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CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 473

ILLUSTRATED ARTICLES:
The Electric Lighting Plant of the Fuerst Bismarck ... 475
Deductions and Experiments on Rotary Currents, by A. du Bois Reymond ... 477
Electrical Cable Testing, by Henry W. Fisher ... 481
Another Early Granular Carbon Rheostat, by A. M. Tanner ... 485
The Perry Engine Indicator ... 485
A New Fan Motor ... 486
The Johnston Electric Invalid Chair ... 486

MISCELLANEOUS:
Latest Foreign Electrical News ... 474
History of Electricity, by P. F. Mottelay ... 474
The Covetous Trolley ... 476
Concerning Lightning Rods, by Elihu Thomson ... 476
The Paris Electric Meter Competition ... 479
Some Effects of Alternating-Current Flow in Circuits Having Capacity and Self-Induction, by J. A. Fleming ... 480
Experiments on Foucault Currents, etc., in Dynamos, by R. H. Housman ... 482
The Riverside Park Electric Railway ... 483
Association of Railway Telegraph Superintendents ... 483
The Use of Slate for Electrical Purposes, by T. J. Murphy ... 485
Factory Lighting ... 486
A Simple Voltaic Battery ... 486
Electricity Developed by Water Power ... 486
Moonlight Tables for July ... 486

FINANCIAL INTELLIGENCE: The Electrical Stock Market, 487; New Incorporations, 487; Affairs of the Companies, 487.

SPECIAL CORRESPONDENCE: New York Notes, 487; New England Notes, 487; Western Notes, 487; Philadelphia Notes, 487; Southern Notes, 487; English Notes, 487.

ANSWERS TO CORRESPONDENTS ... 488

NEWS OF THE WEEK: The Telegraph, 488; The Telephone, 488; The Electric Light, 488; The Electric Railway, 489; Personals, 489; Legal Notes, 489; Miscellaneous Notes, 489.

INDUSTRIAL AND TRADE NOTES ... 489

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 490

An Optical Engine Indicator.

WE give this week quite a complete account of Prof. Perry's new steam-engine indicator, to which some reference was made in our cable dispatch a couple of weeks ago. A glance will show that the new instrument is of extreme simplicity, with moving parts of very small weight and few in number. The diagram made is continuously visible and the regulation of the engine under varying loads can be watched with the greatest ease. The only questionable feature about the instrument seems to be the operation of the flexible diaphragm that serves as a substitute for the piston of the ordinary form of steam-engine indicator. The diaphragm is not certain to give regular action when subjected to considerable variations, and trouble has been found with it in one or two similar instruments. To be sure, in aneroid barometers it gives very regular and accurate results, but under these circumstances its fluctuations are very small in amount, and relatively slow. It would require a rather extensive comparison of Prof. Perry's indicator with other instruments to determine its absolute accuracy for the purpose of computing indicator cards; in its present form it is not so well fitted for this use as for the watching of regulation, looking after the adjustment of valves and analogous purposes. The engine indicators generally in use, however, leave considerable to be desired in the way of accuracy, so that a wide field is left for innovations like the present.

The Chemistry of Secondary Cells.

IN our cable this week is a note on an interesting paper on this much investigated subject. Ever since the time of Planté, the exact action occurring in accumulators has been the theme of an indefinite amount of discussion, and although very valuable contributions have been made to our knowledge of the subject there have always remained a certain number of inexplicable points. Some of these may now be very well accounted for by the presence in the electrolyte of an oxidizing substance so active and unstable as hydrogen dioxide. It has long been noted that curious time phenomena occur in the discharge of secondary cells, the principal of these being abnormally rapid exhaustion at high discharge rates, and partial recovery from this after a period of rest. The presence of the oxidizing agent in question casts considerable light on these obscure phenomena. It is rather singular that, in spite of the fact that the presence of hydrogen dioxide has been noticed before, more notice has not been previously taken of its chemical effects.

More About the Trolley Wire.

ON another page we print a rather spicy bit of comment, by a well known electrician, on some of the slurs cast by the metropolitan press upon electric traction. We have referred to this matter over and over again, but renewed attacks furnish good reason for further remarks. There are of course legitimate objections, mostly æsthetic, to the introduction of the trolley wire on city streets, but these are usually neglected by the opponents of the trolley system in favor of a collection of mendacious assertions and hypothetical objections that are insults to the intelligence of every man who is acquainted with the facts. If a single person had ever been killed by the current from an electric railway wire then a reference to the "deadly trolley" might have some excuse for existence. As it is, however, it would be more reasonable to launch jeremiads against high-stoop houses on the ground that some unfortunate occupants have been killed by falling down the steps. It may be that the trolley wire is not a beautiful object and might incidentally temporarily obstruct the street, but why not, on the same grounds, make savage assults on the fire-alarm wires and telegraph and telephone wires of every sort? For the trolley wire is only one, and serves a multitude of people, while the name of the telephone wires is legion and they are a convenience to a very small portion of the population. Abuse of the electric railway seems to have risen almost to the rank of a popular fad in and about New York, and perhaps opposition to it is useless; nevertheless an occasional vigorous attack like that of Mr. MacFarren may open the eyes of the purblind worshipers of the altogether lovely cable system and the idolized bobtail horsecar to a partial realization of their condition.

Rotary Current Motors.

WE give elsewhere an interesting paper by A. du Bois-Reymond on rotary currents and their uses. By rotary currents the author means a combination of alternating currents in such phase as to produce a rotary field. This may perhaps be best illustrated by referring to the conical pendulum frequently found in physical laboratories, where a ball suspended and acted upon by two forces at right angles is forced into elliptical or circular motion. It is too bad, by the way, that in this paper Mr. Nikola Tesla, who was in the field every bit as early as Ferraris, is not properly credited with some of the principles which he first announced and has done so much to develop. In fact, the rotary current motor became known principally through the efforts of Mr. Tesla, although considerable work has been done upon it by various experimenters. The general discussion of the subject, however, given in the paper in question furnishes a very clear idea of the principles involved and the general methods of construction followed. It may be noted that motors on this principle are to be used in the coming long-distance transmission of power at the Frankfort Electrical Exhibition; it should be said too that in this work a special generator will be employed following the method laid down and the practice followed by Mr. Tesla rather than the devices of Ferraris for obtaining the requisite difference in phase from a single alternating current. The objection to this latter plan is that a variation in the self-induction of any part of the circuit, such as is sure to occur with the varying loads on the motor, throws the phases of the two halves of the current out of their proper relation to each other. The efficiency of these rotary current motors is very satisfactory, and probably the principal reason that has prevented their extensive use is the necessity of using a special generator, and, generally, more than two wires for distribution.

The Steam Turbine.

IT will be noted in our cable dispatch that Cambridge, England, is to have an electric light station operated by turbo-electric generators. These, as most of our readers already know, are simply dynamos directly connected to steam-turbine machines, in which the piston and cylinder of the ordinary engine are replaced by a system of vanes quite like those used in the ordinary hydraulic turbine. The experiment will be a very interesting one, because it will teach a most useful lesson concerning the practical economy of this class of apparatus. It quite goes without saying that if a large, complicated and costly engine could be replaced by a simple wheel taking very little space and costing a comparatively small amount it would much simplify the practical production of electricity; there would be no belting to care for, no reciprocating parts to break down, no valuable space to be taken up by massive machinery. The whole question depends on the economical use of steam by such simple means, and this is a matter to be determined only by experience. There are even now certain types of work in which the steam turbine can very well be used, as we had occasion to point out some little time since in connection with the Dow turbine, described in our columns some months ago. The point to be demonstrated is the economy to be obtained on a large scale. It is a well-known fact that small steam engines do not compare favorably with large ones in point of efficiency. The same is undoubtedly true of any other steam apparatus, but to an indeterminate extent. If a turbine could give the horse power hour on an expenditure of 30 pounds of steam, practically the figure now reached by most high-speed engines, it would become a very formidable competitor of the engine for innumerable purposes. The development of this new type ought to be encouraged and given a chance to show what can be accomplished by it. The progress of the Cambridge experiment will therefore be watched with the keenest interest by electrical and mechanical engineers, and if the results are made public they will constitute a most important addition to the literature of prime movers.

Lightning Rods.

IN another column will be found an interesting communication from Prof. Elihu Thomson on the subject of lightning rods. Ever since the days of Franklin the operation and utility of the lightning rod has been a subject concerning which questions have been continually raised. In spite of the general impression that the apparatus is useful and desirable there have not been wanting skeptics who have insisted that, as generally put up, rods are ineffective and even dangerous. Furthermore this particular part of the electrical field has been the stamping ground of cranks for years. It is therefore particularly reassuring to have so competent an authority as Prof. Thomson put himself on record regarding the real merits of the question. One thing pointed out that is worth remembering is that a thunderstorm is not stationary, and consequently the effect of the rod in encouraging silent discharge may become very small; however, it undoubtedly, to a certain extent, acts as a potential reducer and provides a path for silent discharge, but inasmuch as the rod forms an extremely small fraction of the total path of the lightning its utility in the particular province mentioned may be very easily overestimated as regards the conductor proper. Prof. Thomson is of the opinion that a half-inch iron rod, or its equivalent, is a sufficiently good conductor to answer admirably, and if properly connected to the earth will prove a very efficient conductor. As regards suitable ground, of course water or gas pipe is unexceptionable; where this is not to be obtained the problem is not so easy. A very good suggestion is the division of the rod into several branches running away from the building and grounded separately. A complete metallic cage is of course well known to be theoretically the most effective protection against lightning, and the only practical question is how far the effectiveness of this can be approximated by a few well-arranged conductors. Another very pertinent point mentioned by Prof. Thomson is the insulation of the rods. His contention that they need not be insulated from the building is a most sensible one, for, as he plainly states, the average insulation given to a lightning rod is not good enough for a telegraph line of relatively very low potential. There is a vast deal of humbug about protection from lightning by means of insulation. Those unfortunate persons who are frightened almost out of their reason by thunderstorms and make themselves ridiculous by hurrying to dark closets, lying down on feather beds with alleged insulating supports, carefully stifling themselves by closing the windows, and doing a great variety of other useless and laughable things, are all unmindful of the fact that, when in response to an enormous electrical strain a half-mile of dielectric between the clouds and the earth gives way, the resulting discharge, after breaking through hundreds of feet of air, is not likely to be stopped in its course by an inch or two of wood or a pane of glass. The real purpose of the lightning rod is to keep the centre of discharge on the outside of human habitations. Lightning frequently plays what are apparently inexplicable pranks, but on investigation they nearly always prove to be simply efforts to get to the earth by the easiest way. If such small obstacles as a stone wall or the side of a house happen to be interposed in its path the lightning simply passes through them and goes on. In summing up, Prof. Thomson's conclusion is one that will commend itself to most electricians—that the simple rod provided by Benjamin Franklin, and suggested in connection with his earliest experiments, is not likely to be substituted or much improved, except as experience may have taught convenient details and the intelligent placing of the conductor with reference to the area to be protected.

Latest Foreign Electrical News.

(By cable from our own correspondent.)

LONDON, June 22, 1891.—At the Conversazione of the Royal Society on Wednesday last there was a magnificent display of electrical apparatus, and Prof. Wm. Crookes, F. R. S., showed some very remarkable experiments on electrical evaporation in vacua. In the same line of investigation Prof. J. J. Thomson, of Cambridge, repeated the extraordinary experiments with vacuum tubes that were shown by him recently, and which have already been described in THE ELECTRICAL WORLD. Perhaps the most interesting apparatus, from a practical point of view, was the electrical meter shown by Prof. John Perry, F. R. S. It is the very latest of his many important experiments in measuring apparatus and is extremely simple both in principle and application. It consists of a copper bell completely immersed in mercury, and rotating between the poles of a very powerful electromagnet with a field designed to be systematically very irregular, so as to generate the maximum amount of Foucault currents. In the model exhibited the retarding force of these was 25 times as great as that which could be obtained by available solid or fluid friction. The principle is an old one, the use of a copper bell being familiar in dead-beat galvanometers, and has already been used, of course, in meters, but so successful has Prof. Perry's arrangement proved that this meter reads from 2 to 100 ampères with an error of less than one per cent. The bell revolves at a maximum speed of one revolution per second. The results of experiments with the apparatus have been highly satisfactory, as the figures given ought to indicate. Most of the trouble met in electric meters is in the lower part of their range, where the friction of moving parts becomes a considerable portion of the total force involved. Since, however, Prof. Perry's meter reads so accurately from 2 to 100 ampères it at least gives promise of working successfully on a smaller scale, even on very low loads.

A paper recently read before the Society for Chemical Industry gives a very full description of the electric manufacture of phosphorus. While the chemical processes for obtaining this element are not difficult, they are somewhat complicated and tedious and a satisfactory short cut to the same result will be important to the resources of chemical manufacture.

A very interesting paper on the chemistry of secondary cells was read last week before the Royal Society, and is a considerable addition to our knowledge of the inner working of the accumulator. The principal point brought out was the presence of hydrogen dioxide in some quantity in the electrolyte. Gladstone and Trube some years ago showed that on testing the liquid between the plates traces of something that might be ozone and hydrogen dioxide have always been found, and, indeed, Plante noticed that hydrogen dioxide and ozone in small quantities were present in the acid. He ascribed the high electromotive force to their influence, pointing out that as these substances are very unstable they are rapidly reduced, so that unless the discharge takes place at once they will have disappeared. The presence of hydrogen dioxide explains several obscure points about the phenomena noticed, among others the tendency toward running down of the cell before the peroxide of lead on the plates is exhausted, for there is a tendency to form peroxide of lead on the lead plates, particularly during rapid discharges, by the agency of the electrolytic compound.

At the celebration of the Faraday Centenary at the Royal Institution on Wednesday last Lord Rayleigh gave an elaborate review of the splendid electrical work of that great investigator.

The City & South London Railway has become a party to what may be a lively litigation. An action against the company has been instituted and an injunction issued by reason of nuisance due to noise and vibration at the generating plant, and the company has been ordered to mitigate the same within two months. In addition it may be noted that the earth currents due to the railway have been observed as far off as Bennett's observatory, three miles away.

The Cambridge municipality, who have been contemplating for some time the erection of a station for electric lighting, decided on Tuesday last to put in a 10,000 light installation. The peculiar feature of this will be the use of Parsons turbo-electric generators, which will thus be put to a test more extensive than any that they have hitherto received.

The Electrolysis of Animal Tissues.

In a recent paper on this subject, entitled "Studies from a Physiological Laboratory," Mr. G. N. Stewart says that it seems that practically the whole of the conduction in animal tissues is electrolytic, and the electrolytes are principaliy the mineral salts, changes in the proteids being produced by secondary electrolytic actions. In simple proteid solutions conduction occurs with great difficulty if mineral salts are absent or if they are present only in small proportions. The effects on the proteids themselves in saline solutions vary somewhat with the current density. The effects of electrolysis on the salts of the muscle were studied by estimating the ash. Striking changes were found to occur which, if produced within the living body, would profoundly modify nutrition.

(*Copyrighted*, 1890.)

Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

According to Dr. Lardner ("Lectures," vol. I., p. 137), Prof. Eberhart, of Halle, and Paul Frisi, of Pisa, first proposed an explanation of the aurora founded upon the following, "1°. Electricity transmitted through rarefied air exhibits a luminous appearance, precisely similar to that of the aurora borealis. 2°. The strata of atmospheric air become rarefied as their altitude above the surface of the earth is increased," a theory which has since been countenanced by many scientists. It has been observed, notably by Dalton, of Manchester, that the primitive beams of the aurora are constantly in a direction parallel to that of the dipping needle, and that the latter appears most affected when the aurora is the brightest. Arago noticed that the changes of inclination amounted, upon one occasion to 7′ or 8′. The discovery that the magnetic needle was agitated during the presence of an aurora has been ascribed to Wargentin (*Am. Journal Sc.*, vol. XXX., p. 227), though it is claimed by the friends of Olav Hiörter (see A. D. 1740), that it was independently ascertained by the latter during the year 1741.

The well-known Swiss chemist Auguste De La Rive has made many important observations upon the electric character of the aurora, the experiments carried on by him in the mountains of Finland being thus described: "We surrounded the peak of a mountain with copper wire, pointed at intervals with tin nibs. We next charged the wire with electricity, and nearly every night during our stay produced a yellowish white light on the tin points, in which the spectroscope analysis revealed the greenish yellow rays so characteristic of the aurora borealis. On the peak of Pietarintumturi we were especially successful, an auroral ray making its appearance directly over and about 150 yards above the copper coil."

A complete list of all auroras appearing prior to 1754 is to be found in Jean Jacques Dortons de Mairan's, Paris, 1731, "Traité Physique de l'Aurore Boréale," and a catalogue of auroræ observed, 1800–1877, has been made up by M. Zenger (*Sci. Am. Supp.*, p. 10,915). One of the most interesting displays is known as the *purple aurora*, alluded to in the Annals of Clan-mac-noise as having appeared A. D. 688. (Biot "Note sur la direction, etc.," *Comptes Rendus*, tome XIX., for 1844, p. 822.) Between Sept. 19, 1838, and April 8, 1839, Lottin, Bravais, Lilliehöök and Siljeström observed 160 auroras at Bossekop (69° 58′ N. lat.) in Finmark and at Jupvig (70° 6′ N. lat.); they were most frequent during the period the sun remained below the horizon; that is, from Nov. 17 to Jan. 25. During this night of 70 times 24 hours there were 64 auroras visible. (*Comptes Rendus*, tome X., p. 289; Martin, "Météorologie," 1843, p. 453; Argelander, in the "Vörtragen geh. in der Königsberg Gesellschaft," bd. I., s. 259.)

A Finnish physicist, named S. Lenström, who had been attached to the Nordenskjold Polar Expedition of 1868, visited Lapland in 1871, and, after a series of important observations, constructed an apparatus that permitted him to "artificially reproduce the light of the aurora." The intensity of this light is so great at times that Lowenörn perceived the corruscations in bright sunshine on the 29th of January, 1786, and Parry saw the aurora throughout the day during the voyage of 1821–1823.

The height of the aurora has been variously estimated, but it is seldom found to be less than 45 miles above the surface of the earth. Father Boscovich estimated at 825 miles the height of the one observed by the Marquis of Poleni on the 16th of December, 1737. The extent of the aurora, according to Dalton, has been known to cover an area of 7,000 or 8,000 square miles.

See "Mem. de Turin," An. 1784–5, vol. I., part 2, pp. 328, 338; Young, "Lectures," vol. I., pp. 687, 716; Herschel, "Prelim. Discourse," pp. 93, 329, 330; *Phil. Trans.*, 1753, p. 350; Müller's "Kosmische Physik"; Noad, "Manual," pp. 225–237; also all the references at pp. 187–196, vol. I., of Humboldt's "Cosmos," Bohn, London, 1849; Mairan, at vol. X., p. 961, "Dict. Univ.," and vol. XXVI., p. 161, of the "Biog. Universelle;" *Trans. Cambridge Phil. Soc.*, vol. I.; "Isis Unveiled," vol. I., pp. 417, 418.

See, likewise, the "Pharsalia" of Marcus Annæus Lucanus, translated by J. Krais, L., pp. 518–527; Plutarchus, "De facie in orbe lunæ," cap. 26; the "Annals" of Caius Cornelius Tacitus, Germania, XLV., 1st ed., Venice, 1470; "Das Polarlicht," H. Fritz, Leipsic, 1881, pp. 4–6, 332; Mairan's "Traité Physique, etc.," 1731, pp. 179–181; Grégoire du Tour," *Lumière Electrique*, 1882, vol. VII., p. 389; Elias Loomis, "The Aurora Borealis, etc.," p. 220 of the Reports of Smiths. Inst., 1865; A. M. Mayer, "Observations, etc.," *Amer. Jour. of Sc.*, Feb., 1871; F. Zöllner's paper in "L. E. and D. Philos. Mag." for May and July, 1872; C. A. Young, *Amer. Jour. of Sc.*, vol. III., 3d S., p. 69; Baron Karl Von Reichenbach's "Physico-Physiological Researches," trans. of Dr. John Ashburner, London, 1851, pp. 5–36, also p. 445, etc., of the translation of Dr. W. Gregory, London, 1850; J. H. Van Swinden, "Recueil de Mémoires, etc.," La Haye, 1784, vol. III., p. 187, etc.; J. E. B. Wiedeburg, "Beobachtungen v. Muth., etc.," 1771; G. W. Krafft, "Observ. Meteor, etc.," in *Novi Com. Acad. Petrop.*, vol. V., p. 400; Giuseppe Toaldo, "Descrizione, etc.," in *Saggj . . . Acad. di Padova*, vol. I., p. 178; Louis Cotte, "Table of Auroræ, . . . , 1768–1779," Paris, 1783; *Journal de Physique* for 1775; *Recueil de Mém. de l'Acad. des Sciences* for 1769.

AURORA AUSTRALIS, OR SOUTHERN POLAR LIGHT.

The earliest account of this phenomenon was given by Don Antonio de Ulloa, as will be seen under date A. D. 1735–1746.

See W. L. Krafft, "Observation, etc.," in *Acta Acad. Petropol.* for 1778, part I., Hist., p. 45.

ZODIACAL LIGHT.

This phenomenon, from its occasional faint resemblance to and association with the auroras, would seem to deserve mention here, though none of the conjectures formed, more particularly by Cassini, Euler, Mairan, Kepler, Laplace, Fatio de Duiller, Schubert, Poisson, Olmsted, Biot, Herschel, Delambre, Olbers or Sir Wm. Thomson attribute to it any electric or magnetic origin.

In the *Report of the Proceedings of the Reale Instituto Lombardo*, 1876, however, appears the account of many observations confirmed by Mr. Serpieri which "demand absolutely" the conclusion that the zodiacal light "is an electrical aurora preceding and following the sun round the earth."

Angstrom asserted that he observed the auroral line in the spectrum of the zodiacal light, and Lewis saw the latter during the aurora of May 2, 1877. De Humboldt, who observed it ("Cosmos," I., p. 126) in the Andes at an elevation of 13,000 to 15,000 feet, as well as on "the boundless grassy plains, the Llanos of Venezuela, and on the seashore, beneath the ever-clear sky of Cumana," believes it to be caused by "a very compressed annulus of nebulous matter, revolving freely in space between the orbits of Venus and Mars." In this connection he refers to Arago in the *Annuaire* for 1832, p. 246, and to a letter published in *Comptes Rendus*, XVI., 1843, p. 687, from which the following is extracted: "Several physical facts appear to indicate that, in a mechanical separation of matter into its smallest particles, if the mass be very small in relation to the surface the electrical tension may increase sufficiently for the production of light and heat."

In Chambers' "Descript. Astronomy," p. 257, the historian Nicephoras is credited with first calling attention to the existence of this phenomenon, to which Giovanni Domenico Cassini gave the name of Zodiacal Light, after determining its relations in space during the year 1683 (*Mem. de l'Académie*, 1730, tome VIII., pp. 188 and 276), but to Childrey belongs the credit of having given to Europe the first explicit description of this phenomenon at page 183 of his 1661 "Britannia Baconica."

See Sturgeon's *Annals, etc.*, vol. II., pp. 140 to 142; Prof. C. W. Prichett's paper in *Sci. Am. Supp.*, No. 126, p. 2,008, and the conclusions reached by Herr Gronemann (*Archives Néerlandaises*) in *Sci. Am. Supp.*, No. 327, p. 5,221; Whewell, "Hist. of the Ind. Sciences," 1859, vol. I., p. 531, and vol. II., p. 609. See Tyndall, "Heat as a Mode of Motion," 1873, pp. 57, 58, 497, 498; J. F. J. Schmidt, "Das Zodiacallicht," Braunschweig, 1856.

A. D. 1684.——Hooke (Dr. Robert), English natural philosopher, gives the earliest well defined plan of telegraphic transmission, in a paper addressed to the Royal Society "showing a way how to communicate one's mind at great distances, . . . 40, 100, 120, etc., miles, . . . in as short a time almost as a man could write what he would have sent." His apparatus consisted of an elevated framework supporting an open screen, behind which were suspended as many wooden devices, or symbols, such as circles, squares, triangles, etc., as there were letters in the alphabet. In the daytime these devices were drawn up by a rope behind the screen and made visible in the open space, while during the night use was made of torches, lanterns or lights.

Hooke also showed, in 1684, that iron and steel rods can be permanently magnetized by strongly heating them and by rapidly cooling them in the magnetic meridian. ("Enc. Brit.," 1857, vol. XIV., p. 3.)

But, what is still more singular, he had, even previous to the above-named date (*i. e.*, in 1667), alluded to the possibility of telephoning, that is, communicating sound through a wire. He thus expresses himself: "And as glasses have highly promoted our seeing, so it is not improbable that there may be found many mechanical inventions to improve our other senses—of hearing, smelling, tasting, touching. . . . 'Tis not impossible to hear a whisper a furlong's distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiplied. And though some famous authors have affirmed it impossible to hear through the thinnest plates of Muscovy glass, I know a way by which it is easy to hear one speak through a wall a yard thick. It has not been examined how far acoustics may be improved, nor what other ways there may be of quickening our hearing, or conveying sound through other bodies than the air, for that is not the only medium. I can assure the reader that I have, by the aid of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light, at least incomparably swifter than that which at the same time was propagated through the air; and this not only in a straight line, or direct, but in one bended in many angles."

* Continued from THE ELECTRICAL WORLD, June 20, 1891.

See Hooke's entire paper in Derham's "Phil. Exp. and Obs." for 1726, pp. 142 to 150; also *Phil. Trans.* for 1684.

For his observations on atmospheric electricity see "The Posthumous Works of Robert Hooke," London, 1705, p. 424.

A. D. 1684.——Sturmy's *Mariners' Magazine* for this year, of which a copy can be seen in the library of the British Museum, contains an account of the deviation of the compass and its tendency to give misleading directions on account of local attraction.

See *Chambers' Journal*, vol. III., No. 60, for Feb. 24, 1855, p. 132, and vol. XII., No. 300, for Oct. 1, 1859, p 246.

A. D. 1686.——Maimbourg (Louis), French historian, relates this instance of the employment of the magnet at chapter VI. of the Rev. W. Webster's translation of his "Histoire de l'Arianisme": "Whilst Valens (the Roman emperor) was at Antioch . . . several pagans of distinction, with the philosophers, . . . not being able to bear that the empire should continue in the hands of the Christians, consulted privately the demons . . . in order to know the destiny of the emperor and who should be his successor. . . . For this purpose they made a three-footed stool, . . . upon which having laid a basin of divers metals, they placed the twenty-four letters of the alphabet around it; then one of these philosophers, who was a magician, . . . holding in one hand vervain and in the other a ring which hung at the end of a small thread, pronounced . . . conjurations, . . . at which the three-footed stool turning around and the ring moving of itself, and turning from one side to the other over the letters, it caused them to fall upon the table, . . . which foretold them . . . that the Furies were waiting for the emperor at Mimas; . . . after which the enchanted ring, turning about again over the letters in order to express the name of him who should succeed the emperor, formed first of all these three characters, T H E O; then, having added a D, to form T H E O D, the ring stopped, and was not seen to move any more, at which one of the assistants cried out, . . . 'Theodorus is the person whom the gods appoint for our emperor.'"

Maimbourg's biography is given at page 58, vol. IV., of the "English Encyclopædia."

A. D. 1692.——Dr. Le Lorrain de Vallemont relates, in "Description de l'Aimant," etc., which he published at Paris, that, after a very severe wind and rain storm during the month of October, 1690, the new steeple of the Church of Notre Dame de Chartres was found to be so seriously injured as to necessitate demolition. It was then observed that the iron cross was covered with a heavy coating of rust, which latter proved to be so highly magnetic that a special report upon it was made in the *Journal des Savants* by Mr. de la Hire, Dec. 3, 1691, at the request of Giovanni Dom. Cassini, and of other members of the French Royal Academy.

See more particularly pages 4, 30, 66, 74, 89 to 90 of the above-named work.

A. D. 1693.——Gregory (David), who became professor of astronomy in Oxford mainly through the influence of Newton, communicates, in a manuscript volume of notes and commentaries, the result of his observations on the laws of magnetic action.

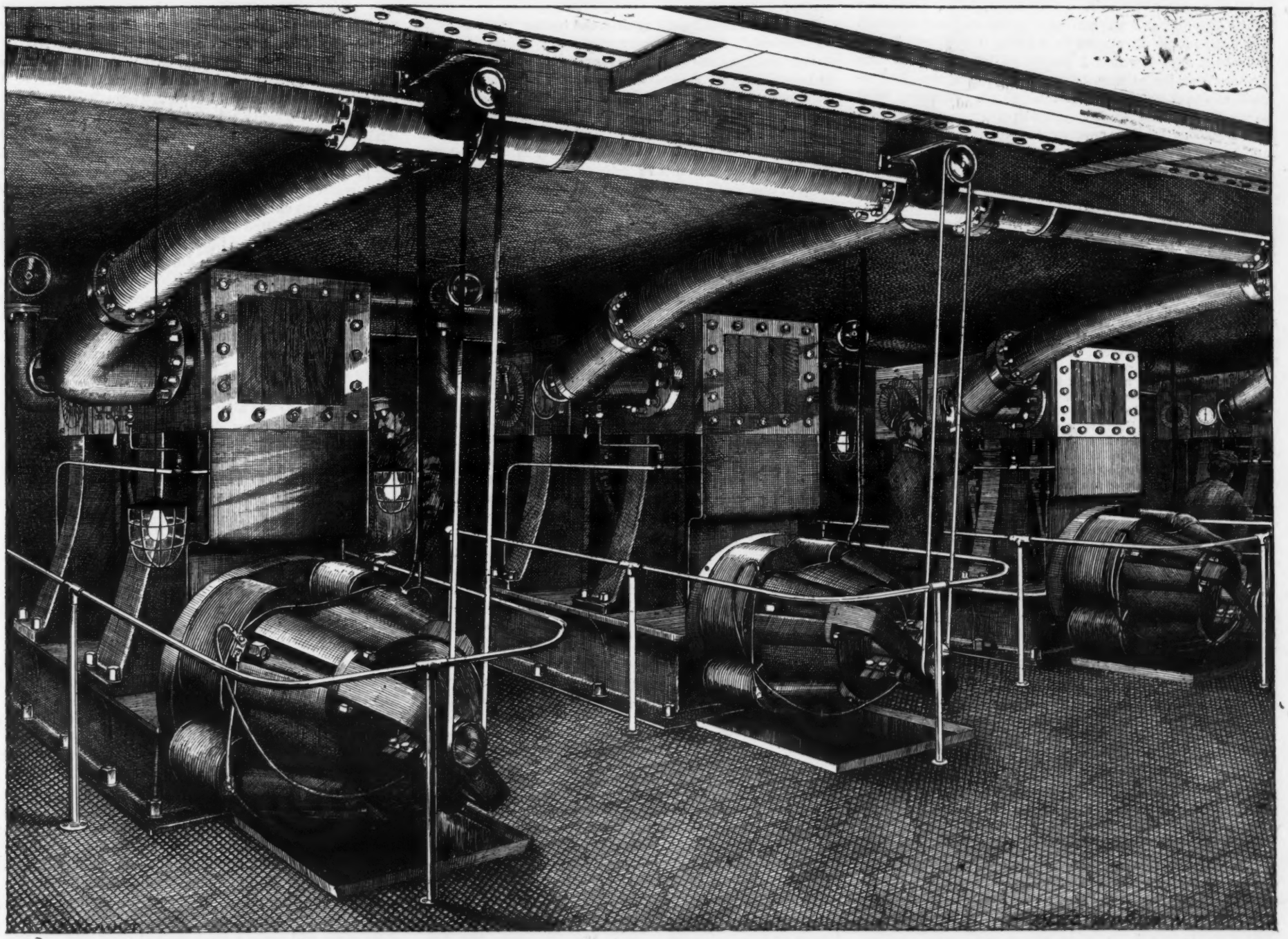
See Noad, "Manual of Electricity," 1859, p. 525.

The Electric Lighting Plant of the Fuerst Bismarck.

One of the finest additions to the fleet of Atlantic liners is the new steamship the Fuerst Bismarck, of the Hamburg-American Company. It may be worth while to say a word about the ship before passing to the arrangements for electric lighting, which are especially complete. The Fuerst Bismarck is, unlike most of the ocean racers, a German-built vessel. She came from the yards of the Vulcan Shipbuilding Company at Stettin, and was launched on November 29, 1890. Her length is 502½ feet, and her beam, which is comparatively wide as compared with the practice of 10 years ago, is 57½ feet. Her nominal tonnage is nearly 12,000. Like all the modern steamers, she is provided with twin screws, and is divided lengthwise from upper deck to keel by a solid bulkhead; beside this each side is also provided with numerous bulkheads. The port and starboard engine rooms are duplicates of each other, and are equipped with triple-expansion engines of 7,000 h. p. each. The boilers are nine in number, in three different compartments, and each set has independent connections with each of the engines. Besides these there is an extra boiler on the upper deck above the water line, to be used with the pumps in case of accident to the main machinery. Like many of the new vessels, the Fuerst Bismarck has a double bottom, in which water ballast can be carried when necessary. The two screws are 18 feet in diameter and of 32 feet pitch, and the speed made in the first passages across the ocean has been very high. In fact the steamer holds the record from Southampton to New York.

The fittings throughout the vessel are of a very elaborate and handsome description. The ship is lighted throughout with incandescent lamps. The dynamo room, shown in our illustration, is a model of its kind. It is situated well aft on the port side, rather low down in the vessel. The generating plant comprises four 400-light dynamos, each coupled directly to an upright compound engine. These machines, like the rest of the electrical equipment of the vessel, were furnished by Kummer & Co., of Dresden. The dynamos are four-pole machines with Gramme armatures, and are compound wound for a potential of 100 volts. The commutators are of unusually large and solid construction and on each of them bear four copper brushes 90 degrees apart. The engines are intended to work on 160 pounds of steam, and at a normal speed of 450 revolutions per minute. Aside from the electrical apparatus for maintaining the voltage constant, a speed indicator is permanently fixed to each engine, so that the slightest variation in the revolutions can be watched for and corrected. The switchboard is of very handsome and convenient construction. There are 12 circuits connected, and any dynamo may be placed on any one of the circuits; this is accomplished by the usual German arrangement of crossed sets of bus bars with plug switches. The upper bars, however, are arranged to slide, so that when any given bar is plugged in, the remaining plug holes do not coincide with any of the holes in the bar beneath, so that only one dynamo could by any chance be thrown on a single circuit. Of course, in addition to this general switch there is the usual accompaniment of accessory apparatus, 12 switches for the circuits, four voltmeters, four ammeters, and the like. Altogether the plant is a very compact one. A little over 1,000 lights are installed in all parts of the ship. There are no large chandeliers, but the lamps are scattered about, mostly on neat, separate fixtures. They are nearly all 25 c. p. lamps, most of them having frosted bulbs, as is frequent in English and continental practice. The saloons, when all the lights are turned on, present a most brilliant exhibition, which is enhanced by their large size, the main saloon on the upper deck being 72 feet long by 40 wide, while another 50 feet by 22 is situated on the main deck. The decorations are elaborate and gorgeous, and taken altogether the equipment of the new steamer is a great credit to its designers and builders.

It may be added that not only is the Fuerst Bismarck one of the fastest steamers on the Atlantic, but is also



A GERMAN LIGHTING PLANT ON THE FUERST BISMARCK OF THE HAMBURG-AMERICAN LINE.

one of the most economical in fuel, as her coal consumption is in 24 hours only about 260 tons.

The Hamburg-American Company may well be congratulated on this addition to their fleet, for she is an interesting object, not only to the public, who appreciate the elegance of her equipment, but to the electrical and mechanical engineer as well.

The "Covetous Trolley."

The following correspondence speaks for itself, and is inserted here as a vigorous protest against the treatment that the electric road has received from the metropolitan press. There may be in the minds of many objections to the trolley system, but these do not grow more forcible by exaggeration, nor can insensate abuse logically take the place of facts. The most incomprehensible feature of the case is the animus of the attack. The *Tribune* has usually sustained its worthy reputation for editorial ability and fairness, but in the present issue it has not only shown gross injustice but has refused a hearing to those injured.

To the Editor of the Electrical World:

Upon a recent visit to New York I bought my usual copy of the *Tribune*, and was attracted by the inclosed editorial. The indignation developed by reading it resulted in the following reply, which I presented in person to the *Tribune's* proper representative, receiving a complete refusal to admit it to their columns. Charles A. Dana used to say that Horace Greeley's journalistic code was "always give a hearing to your opponents. Never attack a person and refuse to let him make answer in the same column." How widely has the *Tribune* departed from the principles of its founder, and what possible motive can carry it so far as it has gone in its attacks upon electrical rapid transit? The following are the editorial that so grossly misrepresents the facts of electric traction and the reply.

S. J. MacFarren.

"Citizens of Brooklyn are beginning to make their aversion and hostility to the trolley system of electric propulsion seen and felt. They have not made war on the proposed scheme too early, or with excessive zeal. On the contrary, there was some danger, until within a few days, that they might lose the battle by default, and even now a more general and determined opposition would be desirable. It could not have been imagined a year and a half ago when the fear and horror occasioned by the death of Feeks had culminated in a popular demand for the destruction of overhead wires, that within so short a time projects for the introduction of the dangerous, disfiguring and delusive trolley in this city and in Brooklyn would be tolerated by public officials, pushed forward with confidence by avaricious promoters, and regarded with comparative indifference by the people of the two cities. But the fact that short memories and general heedlessness are the main reliance of those who hope to increase their revenues at the expense of the community makes the duty of repeated protest and condemnation all the more binding upon those who are not forgetful nor unconcerned.

"If there is a single city or town in the United States where the trolley system is in operation a majority of whose inhabitants are contented and happy in its possession they have hitherto failed to make known their state of mind. The evidence is all the other way. The trolley is universally indicted on numerous charges, but chiefly on these four: that it is dangerous, inefficient, obstructive, and unsightly. Taking these complaints in reverse order, the last, we conceive, admits of no rational argument in rebuttal, even though an advocate of the enterprise now seeking to establish itself in the Annexed District had the temerity to descant upon the loveliness and artistic worth of the poles with which his company was prepared to embellish that region. That the overhead wires are an obstruction firemen have repeatedly declared and proved to the dismay of numerous owners and tenants of burning buildings. It is admitted that the trolley is efficient as a means of profit to the proprietors, but there is a huge volume of testimony to its inefficiency as a means of transportation. Under perfectly favorable conditions it does undoubtedly do its work reasonably well; but it is peculiarly liable to break down just when public need of it is greatest. An ice storm is always expected to interrupt its operations even if it does not bring the wires in a tangle to the ground. The experience of Boston in this particular has been exceptionally uncomfortable and irritating, but the same inherent defect has been frequently exposed elsewhere. Lastly, the existence of overhead wires carrying a current of electricity capable of operating a line of street cars is and, in the nature of the case, must be a constant menace to public safety and a common cause of fatalities. Any assertion can be readily enough contradicted, but this is an assertion which cannot be disproved so long as a dismal record of tragedies remains undisputed.

"The foregoing arraignment of the trolley is not ours. It is the result of unhappy experience in many places. There may be lonely wastes where overhead wires might serve the purposes of transportation cheaply and inoffensively, but in cities they are intolerable. It will be remembered that after his secret mission to Boston Mayor Grant constructed this curious syllogism: The trolley is a nuisance in populous places; the trolley has a remarkable faculty of making places populous; hence I advocate the trolley wherever it is certain to become a nuisance in the near future. Accepting one of the Mayor's premises as a fact and the other as a possibility, sensible persons will be apt to draw a very different conclusion."

Allow me to show my surprise at the tone and substance of an editorial in a late issue of the *Tribune* opposing the introduction of electric traction into Brooklyn, and entitled "The Covetous Trolley." The *Tribune* has ranked so high in my estimation during all my reading life for accurate statement, shrewd opinion and fair judgment, that the shattering of my journalistic idol seems as complete as it is sudden.

Had I read in an obscure corner of the news columns that London was the capital of the Congo Free State, that Mr. Cleveland's appetite was the cause of the "Mafia" lynching in New Orleans, and the policy of reciprocity was responsible for the late Indian outbreak, I should have pitied the reporter whose intemperance was losing him his situation.

But when I read in your most prominent editorial column a far more absurd farrago of misstatement, clothed in a close imitation of the densest ignorance, what am I to suppose?

If the writer of "The Covetous Trolley" is so ignorant as he pretends he should resign in favor of the first lineman he meets on the street.

He says "any assertion can be easily contradicted." This is certainly true of his own. For instance, he says: "If there is a single city or town in the United States where the trolley system is in operation a majority of whose inhabitants are contented and happy in its possession they have hitherto failed to make known their state of mind. The evidence is all the other way."

But *he* does not give evidence, *he* does not name *one* city or town as a reference, and he carefully *conceals* from the blind readers he so blindly leads that a neighboring journal of equal respectability with your own has recently printed replies from the mayors of nearly 60 cities and towns possessing electric traction, nine-tenths of which praised trolley rapid transit with more or less enthusiasm and *not one* condemned it. (See Electrical World, November, 1890.) Many of these officials denied explicitly that the trolley system is considered dangerous by their people.

The second indictment against the trolley is, that it is "inefficient." If the contrary were not true (as is easily established from the concurrent testimony of all intelligent and unprejudiced observers everywhere) why should the "avaricious promoters" of rapid transit schemes stigmatized so viciously generally prefer it to horses on the one hand and cable on the other? And are electric traction men *really* more "avaricious" than horse, cable or steam railway men or journalists?

Then, how unfair it is to refer to Lineman Feeks' death as an argument against electric *railway* wires, which have never killed or maimed a human being. Because a light wire carrying 2,000 volts pressure killed Feeks, therefore a railway wire carrying 500 volts will or would or "must" be deadly, says your electrical "expert."

Is he a lineal descendant of the old woman who declared that "a gun is dangerous without lock, stock or barrel, for Joan beat me with the ramrod"?

Your writer does not call the steam engine "delusive," and urge Brooklyn to dispense with the use of *steam* because a boiler made, inspected and licensed for 150 pounds pressure blows up at 500; yet, if his mind *ever* "works," he must know that there is probably a similar limit of safety and danger in electrical pressure, and that electric railway men will have considered it. He does not say the steam engine "system" is "inefficient," though he should know that it only utilizes about 10 per cent. of the stored energy in the fuel it consumes.

Why does he conceal that the firemen's complaints against overhead wires are generally if not invariably directed against light and telephone and telegraph wires, which are strung by the hundreds over the sidewalks, and where fire ladders, etc., are to be hoisted, while electric railway overhead wires need be but two, and those in the middle of the street?

The *animus* of the article seems anything but creditable to a great journal, and a case must be very weak to need such logic and alternate suppression and exaggeration of facts as these.

Is it a fact that an electric trolley railway is "peculiarly" liable to stoppage in storms, etc., as stated here?

Does your writer not *know* that the electric motor is immensely superior to animal traction in these emergencies, and when properly equipped and managed equal to the cable? Does he doubt that any so-called evidence to the contrary is the result of defective equipment or stupid superintendence?

Where is the "dismal record of tragedies" relied on to prove the dangerous character of electric railway wires? Can your writer cite *one* human life so lost? only one, "as an evidence of good faith"? Can he name *one* city whose inhabitants would *probably* vote to return to horse cars after a year's trial of electric traction?

Then, if it is true that the cable is too costly and animal traction too slow for the vast majority of cases, is there not plenty of room for the trolley system as the *only* present *commercially* successful form of electric traction? And cannot the great metropolitan press afford to treat and discuss with fair respect an honorable and rapidly growing industry, the investments in which (by the shrewdest business men of their respective localities) are without precedent in history?

If not, I can as a resident of Pittsburgh, guilty, however, of occasional sympathy with metropolitan criticism of the enterprise of Pennsylvania cities, begin to understand why Chicago got the World's Fair and New York still longs for the Grant Monument.

Of course, as a *Tribune* trained Republican, I cannot differ with you on the Donnybrook Fair policy of hitting a (Democratic) head wherever seen; and why not Mayor Grant's?

But while, like the late A. Ward, not exactly in the "prophet business" myself, I think I have inherited second sight enough to predict that "the last American" is much more likely to stumble over popular monuments to the mayors who advocate and aid rapid transit than he is to find any inscriptions in honor of the journalists who oppose it.

Concerning Lightning Rods.

BY ELIHU THOMSON.

The following queries were sent out by one of the metropolitan journals:

Do lightning rods really afford any protection?
What is the nature of the electrical discharge?
What is the correct theory of its cause?
What is the correct theory of the action of lightning rods? Should they be insulated or not?
Does their effectiveness depend on their cross section or surface?
Do you agree with the ideas advanced by Mr. N. D. C. Hodges in his paper on this subject, read before the Institute of Electrical Engineers, April 21, and reprinted in part in The Electrical World of May 2?

In regard to the utility of lightning rods I think there can be no question that a properly constructed and arranged lightning rod will afford complete protection of buildings from the effects of lightning discharges. In the first place, in my opinion, the lightning rod, contrary to the opinions put forward and even advocated in the books, does not have any considerable effect in conducting off discharges from the clouds silently, for the reason that the development of the conditions of the discharge from the cloud to the earth is oftentimes too sudden to allow any rod or rods to effect this work of conduction in a silent manner. The cloud ordinarily during thunderstorms is moving rapidly and the lightning strokes are found most frequently where the densest rain exists, and it is easy to see that a building may suddenly be drenched with rain and the conditions for a stroke brought about at such a rate that a lightning rod or rods could not ward off a discharge by conducting the electricity silently to the earth. In such cases what is more likely to happen is this, that the highly charged cloud existing over the neighborhood of the building provided with a rod will, if the conditions are favorable, suddenly discharge itself into the rod and the discharge be thus carried to ground. On the same reasoning it must be admitted that the presence of a lightning rod may, and perhaps often does, conduce to a building being struck by lightning, but it is much better to have the building struck a number of times without doing any harm than to run the risk of having it once struck while without any means of conduction of the current to the earth except through the poorly conducting portions of the building, which are almost sure to suffer injury or destruction.

I do not think that lightning rods are of much utility in the cases of buildings which have metal pipes running from the ground up to the highest story and through the roof, especially if these pipes should extend to a considerable height above the building or above the highest part of the building. In case the building has a metal roof with pipes running from the ground to the roof there is little liability of damage being done below the roof, but any chimney which projects above the roof might be struck and shattered. In such cases a connection from the pipe or metal of the roof to a short rod running up the chimney and extending above it a short distance would be advisable. Lightning rods are of but little use for buildings adjoining tall chimneys or church spires themselves provided with good lightning conductors. The actual area which is protected by a church spire provided with a lightning conductor has never been satisfactorily determined, but it is probably at least equal to that of a circle whose radius is equal to the height of the spire or chimney above the top of the building to be protected. All that I have said in relation to the effectiveness of the lightning rod implies of course that it be properly put up—that is, put up with a knowledge of the conditions of the service which is to be had from it—and that it be thoroughly connected with the ground at its lower end. Merely running the end of the rod into the ground a short distance, as sometimes done, is by no means sufficient. A connection of the system to gas or water pipes generally furnishes a good ground. The running of the lower end of the rod, made of some metal which can not be easily corroded, either into a pit or well filled with broken coke or tin scrap will make a good ground, provided the well is deep enough to be always in a moist state. A still better way is to fork the end of the rod into several branches which run away from the building and pass downward into several small pits or wells with the conducting material, such as coke, iron borings, tin scrap or the like, laced in them. The most perfect lightning protection is obtained when the building is virtually in a metallic cage, the parts of which in connection with the earth are very thoroughly grounded or connected with the moist stratum. Such thoroughness as this is, however, not necessary. With even a large building the carrying of a conductor down each corner and grounding it as above mentioned would be sufficient. Of course the rod should have sufficient metal in it not to be injured by the heaviest possible discharge which would be liable to pass over it. It should, in other words, be built with a factor of safety, so as to be able to carry to the ground all the current which could ever reach it from the clouds. I think it is pretty generally conceded that one-half inch iron rod has never been known to be injured by the passage of a lightning discharge through it, and that such rod conducts the discharge freely enough for the purpose. Experience, of course, is to be the teacher in this case. A lightning rod made of galvanized iron pipe, say one inch pipe, used with the screw joints well secured and painted so as not to rust at the joints, would be about as good a conductor as could be de

sired. A flat strip of copper securely tacked to the building and running down its corners, the dimensions of the copper being, say, $\frac{1}{16}$ inch thick by 1½ inches wide, would also answer, and is in many respects a good form of conductor. If the metal aluminium becomes cheap enough I think an iron bar covered with this metal would be an excellent conductor on account of the small liability of the aluminium to rust.

In regard to the query, What is the nature of the electrical discharge? I would say that so far as I know it is the conversion of the electrical energy into the energy of light and heat. To make this clear we must understand the conditions before a discharge, so far as they can be understood. When a cloud is in that state which causes it to emit thunderbolts, to use a common expression, it is possessed of what is known as an electrical charge; that is, its particles are in a condition of strain in relation to the earth or another cloud, which strained condition may relieve itself by a discharge. This condition is expressed by saying that the cloud is at an electrical pressure different from the earth or another cloud, just as the steam boiler may be under a considerable pressure as regards the air around it. The air under the cloud, if the electrical pressure of the cloud is different from that of the earth, is the thing which resists the passage of current, or forms, as it were, a boundary or shell, like the boiler shell, for this pressure. Should this insulating or resisting stratum of air become too thin or the pressure in the cloud become too high, or the resistance which the air offers to the passage of a discharge be lessened by its containing an immense volume of rain falling, a rupture of the air stratum takes place, and immediately there exists a flash of lightning joining the cloud and the earth, which relieves the pressure in the cloud and insures the existence of a lower pressure for a time. Hence, a discharge of a cloud to earth in a lightning flash is simply the relief of the electrical pressure, an action which is repeatedly brought about by this difference of pressure continuing during the storm. There is in the cloud atmosphere a formation of raindrops going on which causes a condensation or accumulation of electricity, and this again and again brings the cloud to the condition of discharge, and again and again it may strike in relieving the difference of pressure. That it strikes in one place, or, as it were, splits the air at one point, simply indicates that the line of discharge or line of the lightning stroke is the axis of a disturbance which has taken place between the cloud and earth, and it is on this line or axis that the energy and the destructive effect of a discharge will be concentrated, although it must by no means be thought that the effects of the lightning stroke are confined to this path. The mere passage of a lightning stroke sets up electrical disturbances over a very considerable area, such as cause trouble on telephone, telegraph and fire-alarm apparatus, circuits, etc. As regards the cause of the existence of the pressure or electrical charge in the cloud I believe it has not been found that any single cause exists which can be regarded as producing all the effects. An accumulation of electricity in a cloud seems to be concomitant with a sudden condensation of vapor which takes place on the cooling or rarefaction of vast bodies of moist air. If the air before the condensation was in any way electrified, however slightly, the condensation or conversion of the cloud into drops of water would be followed by the existence of an electrical charge in the cloud. It has been supposed that the growth of vegetation, combustion, decay, evaporation, friction of dust particles carried up by the wind and such actions might give rise to electricity in the atmosphere However, any portion of the atmosphere so electrified, when carried to an elevation above the surface or becoming part of an uprising current, the moisture in the air condenses at the higher altitudes and forms the thundercloud. This theory accounts for the fact that thunderstorms are very apt to follow hot days in the summer. The layer of air on the surface or near the surface of the ground gets highly heated by absorption of the sun's rays, and, being rendered light by the high temperature, it rises in great columns to altitudes which cause condensation of the water to take place. This makes a fog which very soon may begin to collect into drops and so give rise to rain. The action is so sudden that whatever electricity is present is, as it were, caught in the cloud and held there as a charge, and the gradual coalescing of the fine particles of water in the moist air into raindrops reduces the amount of surface on which the electricity is found, and therefore increases its pressure. This explanation is the best that I can give in popular language. The thunderstorm ceases when the condensing action stops. So also the electric charge is relieved by the numerous discharges or strokes. But of course in the popular sense the storm ceases at a given time when it has passed by, though it may, however, continue for many hours and traverse a great extent of territory. It is found that similar conditions of high temperature often evolve numerous thunderstorms over a tract of country many miles in extent, which storms, though in a measure independent, are really due to the same set of conditions existing.

Concerning the action of a lightning rod in saving a building from harm, this can be briefly stated to be the mere interposing of some good conductor in the path of the lightning discharge, so that the charge can be carried to earth, or the electric strain relieved, without the necessity for following poorer conductors, which, if traversed, would be torn to pieces or destroyed. More scientifically, it may be stated to be the provision of a path or centre of action for the discharge in the vicinity of the building of such a character that the discharge selects it in preference to forming a centre of discharge or path for itself through the building, which may be made of materials not able to carry the discharge without destruction. The concentration of the energy of a discharge on ordinary building material, such as wood, stones, brick or plaster, gives rise to destruction from the mere fact that these substances are not capable of conveying the energy without being highly heated. If wood be suddenly heated the watery vapor in it forms a gas and explodes it. The destructive effects, then, of the electrica ldischarge are due to expansion of gases or the production of vapors within the material damaged.

Lightning rods need not be insulated from the building. It matters very little whether they are or are not insulated, as the ordinary provisions for insulation so far as a lightning discharge is concerned are practically *nil*. The insulation given to a lightning rod is frequently that which is not good enough for a telegraph line, where the pressure of the current on the line may not exceed in all 200 volts, while in the lightning discharge the pressure may be many millions of volts. Where there are large masses of metal in a building it would do no harm as a rule to connect these masses to the ground as well as to the lightning rod; and it may be said also that where a building is filled with masses of metal or machinery damage from lightning could be largely obviated by connecting the various masses of the metal one to the other and to the ground. It is not, however, essential that they be actually connected to the ground; for if a mass of metal in the building is but slightly separated from the ground wire by what is known as a discharge space, it will be quite sufficient to allow lightning to pass. A slight opening between two parts of a conductor constitutes a discharge space. Such discharge spaces and protective arrangements are used commonly on telegraph and telephone lines, in which the lines, although they are not connected to earth at each instrument, may be so near the earth by the provision of a discharge space between the line and earth, that they are practically connected. The effectiveness of lightning rods depends, I think, not alone upon their cross-section nor alone upon their surface. It is as much a mechanical as an electrical question. There needs to be a sufficient cross section of metal not to be melted by any discharge, and it is best that the metal be made in the form of a pipe or flat strip, since the tendency of the lightning discharge is to follow the surface portion of the conductor. This is due to the fact that it is an extremely quick discharge and may take upon itself an oscillating character. This means that each spark which connects earth and cloud is not a stream of something running in one direction, but merely a core or axis for a set of disturbances or reliefs of pressure which may act alternately in opposite directions during the short intervals through which the flash lasts. The oscillating action may be illustrated by fastening the end of a thin steel rod and bending it by carrying the free end to one side. This if let go will be followed by a series of oscillations made very quickly, but which are akin to oscillations of a pendulum. The relief of electrical pressure is in lightning so sudden as to result in the action of relief going too far, after which a relief in the opposite direction ensues, back and forth, until all of the energy of the discharge has been used up in the form of light and heat. This must not be confounded with the action which often occurs during thunderstorms, when two, three, or more separate discharges are visible separately to the eye, and follow down the same path or the track which has been opened by the first discharge. This is a phenomenon common enough and easily observed, but it has no relation to the oscillations of a single lightning discharge. These oscillations, if they exist at all, are in periods inconceivably small, and therefore are not to be discovered by the unassisted eye. Neither do I wish to be understood as subscribing to the opinion that all lightning discharges are oscillating in character. I am convinced from my own observation that very many lightning discharges, particularly those which pass over great lengths of cloud, are more apt to be discharges of some duration. Observation over a long period of years has led me to think that it may be possible that the discharges in some instances have a measurable rate of progress from cloud to cloud and perhaps to earth. The photographic plate which is being more and more applied to the study of lightning discharges will some day resolve this doubt.

I am asked at the conclusion of the queries whether I agree with the ideas advanced by Mr. N. D. C. Hodges in his paper on this subject. He argues that because he has failed to find cases of damage by lightning when the conductor has been dissipated or vaporized that all lightning conductors should be made so that they or a part of them will undergo dissipation on the passage of a lightning discharge and so use up the energy of the charge in the formation of vapor. Now, as lightning does damage only when it avoids the lightning conductor and passes through the building, I fail to see why if it should avoid Mr. Hodges' dissipable affair it would not do equal damage. When the discharge confines itself to the lightning conductor, dissipable or not, such conductor protects. The fallacy in his idea is that it supposes the work of the discharge to be confined to that very short length between the top of the building and the ground. As I regard it, the giving out of energy of a lightning discharge is by no means confined to the building which is struck or to the lightning rod which carries it, but on the contrary this portion of the path receives but a small fraction of the total energy. Whoever has looked out upon lightning during a thunderstorm and watched the vivid streaks of fire connecting the most distant parts of the clouds with the earth will be able to realize what I state to be the fact, namely, that very much the larger part of the energy of a lightning discharge is consumed in the atmosphere itself in producing that vivid light and the intense heat which mark the path of the lightning. When we put a lightning rod of ample dimensions and proper construction on the building with one end in the ground and the other on the roof we have virtually brought the earth up to the roof and shortened the length of the lightning discharge, confining it to that path which may produce light and heat in the air without damage to the building. We thus have all that elongated path in the air still to use up the energy of the charge without any other damage than the terror which comes to nervous people. To provide a lightning rod which is partly or wholly destroyed during a thunderstorm, or which is to be rendered ineffective by dissipation, as Mr. Hodges does, is to invite another discharge coming later to do all the damage it can without any provision for avoidance. No one, indeed, desires to replace a lightning rod during a thunderstorm, and no one desires to renew a rod at all if he can avoid it, or to renew any part of it, as it is well known that a lightning rod of all things is the last thing thought of until a storm comes which demands its efficient service. I would say in conclusion, therefore, that I do not believe that the simple efficient lightning rod provided by Benjamin Franklin and suggested in connection with his first experiments with the kite and key is likely to be superseded except in the matter of improvements in the details and its disposition about the building or the intelligent placing of the rod or conductor where it is most needed.

Too true it is that a great amount of discredit has been brought upon this great invention of Franklin by "lightning rod men," as they are called. Lightning rods have been frequently put up with a vast amount of gaudy finish and a vast amount of useless complexity, numerous points tipped with gold, platinum, or what not, while the earth connection has been made by simply putting the lower end of the rod into the ground a short distance. That such rods protect as often as they do is a matter for surprise, and not that they sometimes fail to protect. In these days of scientific invention there should be no difficulty in obtaining as neat a piece of construction in the matter of lightning conductor protection as in other departments of the electric arts. Too often it is that persons have intrusted their property if not their lives to the care of the merest speculators or charlatans who have provided nothing more than a mere sham and have been roundly paid for it. On the faith cure idea this might be sufficient, for if we had faith in our protection we should be protected. The facts, however, are otherwise, and it is hoped that the educational privileges of the present day will at last overcome all forms of quackery, false lightning protection included.

Deductions and Experiments on Rotary Currents.*

BY A. DU BOIS-REYMOND.

The diagrams, Fig. 1, are copied out of a well-known treatise on physics.† They are meant to show how elliptical and circular polarization of light is obtained. An atom of ether simultaneously performs two simple sinusoidal oscillations of equal period, the directions of which are perpendicular to each other. For each phase the radius vector of the resulting movement is the diagonal of a parallelogram, the components of which are the two distances from the centre which the atom would have reached at that phase if it performed only the one or the other of the two simple oscillations. Thus the curves of the first group in Fig. 1 are obtained, if between the two simple oscillations a phase difference of $\frac{0}{8}, \frac{1}{8}, \frac{2}{8}, \frac{3}{8} \ldots \frac{8}{8}$ of the period occurs and their amplitudes are equal. The curves of the second group, Fig. 1, are obtained in the same way, if the phase difference between the two component oscillations is always 90 degrees or one-quarter of the period, while their amplitudes successively take different values.

Even if the identity of optical and electromagnetic phenomena had not been made an article of our scientific faith by the work of Clerk Maxwell and Mr. Hertz, the merely external similitude of the elliptical and circular polarization and the phenomena of electromagnetic rotation produced by rotary currents would strike us. And likely enough this analogy may have influenced the inventor of electromagnetic rotation, Mr. Ferraris, in the execution of his fundamental experiments.

He simply substituted the two superposed oscillations of the atom of ether by the variations of two superposed magnetic fields and obtained a resulting field, the direction and intensity of which is defined by the direction and length of the radius vector of the corresponding curve of optical oscillation.

* From *The Electrical Review* (London).

† Lehrbuch der Physik und Meteorologie von Dr. Joh. Müller. 8te. Aufl., Bd. II. Abth. I., S. 611.

When such a rotary field is to be employed to drive electromotors, its intensity and angular velocity ought to be as nearly as possible constant, or, to use the optical expression, perfectly circular polarization ought to be aimed at. Therefore the conditions which underlie the attainment of this object deserve our particular attention. In Fig. 1 we find that the oscillation curve becomes a true circle only in those cases in which the amplitudes of the two component oscillations are equal, and in which the phase difference is 90 degrees. But here the analogy fails, because the optical oscillations only interfere in such a way that the directions of the two components inclose an angle of 90 degrees. Mr. Ferraris, also, has not gone beyond this point, most likely because the optical polarization theory was before his mind's eye. He begins his famous treatise on electrodynamic rotations* with these words:

"Sia o un punto di uno spazio nel quale si sovra pongono i campi magnetici prodotti da due correnti elettriche; le direzione o x ed o y che hanno i due campi magnetici nel punto o sieno diverse, per esempio perpendicolari l'una all' altra," and he sticks to his assumption through the rest of his paper; whereas, if we do away with this supposition, we find that perfectly circular oscillation curves always result, supposing only that the amplitudes of the two component fields are equal, and that the angle which their directions contain is the supplement of the angle of phase difference.

Fig. 1.

Fig. 2.

If more than two component oscillations are combined, this rule is subject to a number of modifications, which, however, we need not follow up.

In the first case of the first group, Fig. 1, the phase difference was naught. If we turn the second component till it incloses an angle of 180 degrees with the first, the resulting oscillation curve shrinks away and becomes a point, Fig. 2, first case. If we make the components in the second case to contain an angle of 135 degrees, we will obtain a circle, Fig. 2, second case. In short, the first group of curves in Fig. 1 becomes the group Fig. 2, if we make the angle contained by the components equal to the supplement of the phase difference. However, the diameters of the circles so obtained, or in electrodynamic rotation the intensities of the rotary fields, are not equal to the amplitudes as in the circles in Fig. 1, but only equal to the product of the amplitude into the sine of the angle contained by the components.

From the point of view thus gained we can easily form a judgment on the nature of the resulting rotary fields obtained in a few practical cases that have been described in the literature of the last few years. In the first place, we would consider the two experiments described by Mr. Ferraris himself.

He says that the two alternating currents necessary for exciting the component fields may be obtained from one single alternating current. He excites the coil, which makes the one component field, and the primary, the coil which makes the other component field, with the secondary current of a transformer. By giving each coil the right number of windings, it is easy to make the ampère windings in each and thereby the amplitudes of the component fields equal.

However, the phase difference between the primary and secondary current of a transformer is always a larger angle than 90 degrees. Suppose, for instance, that this difference amounts to 135 degrees (a case which is altogether within the limits of practicability), then the radius vector which defines the resulting field obtained would not describe a circle, but would describe one of the ellipses shown in the fourth and sixth case in the first group in Fig. 1. Had he hit upon the idea of disposing his exciting coils in such a way that their magnetic axes had contained an angle of 45 degrees, he would have obtained the corresponding curve in Fig. 2, viz., constant angular velocity and constant intensity.

Exactly the same may be said of his second method. He splits an alternating current into two branches, into one of which he inserts a small resistance and great inductance, into the other a large resistance and small inductance. The phase difference in this case may approach 90 degrees, but will always be smaller. Let us assume it to be 45 degrees, for instance, then the resulting curve will again be one of the two ellipses, case second and eighth in the first group of Fig. 1, supposing, of course, that the ampère windings in both coils have been made equal. Again, he might have obtained perfectly circular polarization of his resulting field if he had disposed his coils so as to contain an angle of 135 degrees.

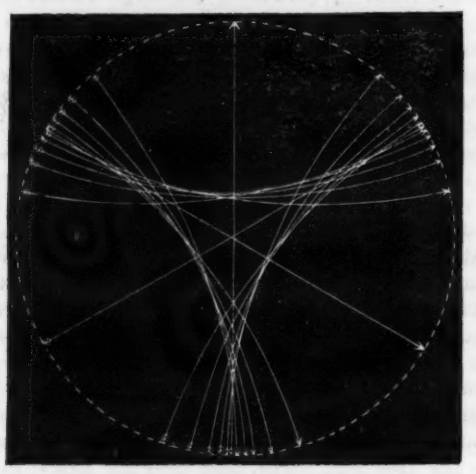


Fig. 8.

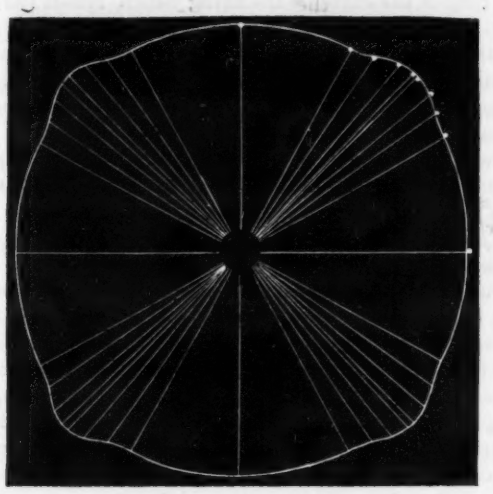


Fig. 9.

The first of Mr. Ferraris' two methods has been introduced into regular use in the Schallenberger meter. This well-known instrument substantially consists of a coil, through which flows the alternating current that is to be registered. A second coil, short circuited in itself, is disposed in such a way that the magnetic axes of both contain an angle of 135 degrees. The resulting rotary field turns an armature, the revolutions of which are counted.

In the second coil a secondary current is generated, and according to the well-known rules that govern the processes in a transformer the intensity and phase of the primary and secondary currents in this case will be approximately as $\sqrt{2}:1$, and the phase difference between the two will be 135 degrees. Therefore neither will the amplitudes of the two component fields be equal, nor will the phase difference correspond to the angle contained by the components. Consequently the resulting oscillation curve will be a stretched ellipse. However, since Mr. Schallenberger does not intend his apparatus to yield an appreciable output, the fluctuations of the field intensity will not do much harm. They may even be of some use by counteracting the mechanical inertia of the armature.

Still more imperfectly than in the Schallenberger meter the conditions for constancy of the velocity and intensity of the rotary field are fulfilled in one of the newer motors of Mr. Tesla, in which the inventor makes use of the second Ferraris method.

In the description of this motor, which The Electrical World, vol. XIV., p. 382, gives, a four-pole design is chosen, so that the angles contained by the composing fields ought to be expressed as parts of half a circumference, or by half degrees, in order to suit our rule. Eight radial electromagnets are disposed at equal distances on the inside of an

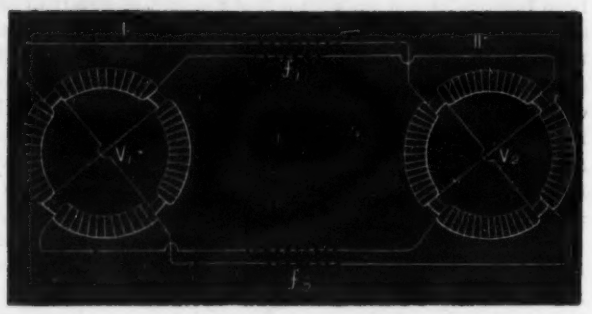


Fig. 3.

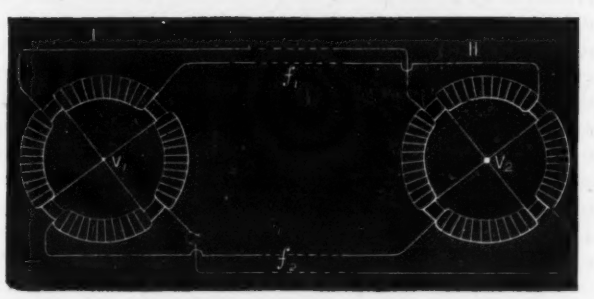


Fig. 5.

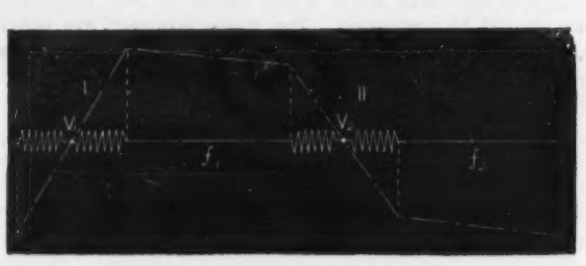


Fig. 4.

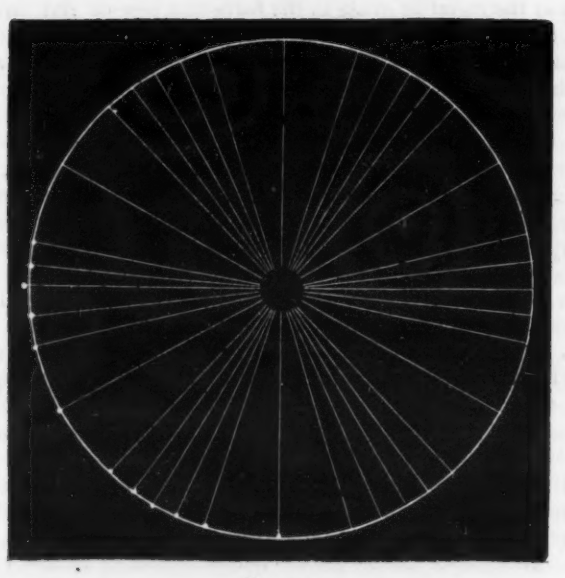


Fig. 10.

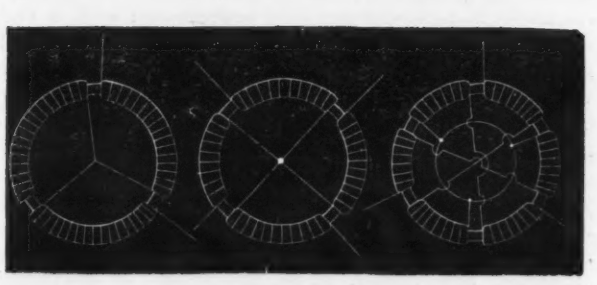


Fig. 6.

DU BOIS-REYMOND'S DEDUCTIONS AND EXPERIMENTS ON ROTARY CURRENTS.

Three-coil motor.				Six-coil motor.								Four-coil motor.	
Measured direction of the north pole in degrees.	Measured direction of the south pole in degrees.	Mean direction in which the intensities were measured.	Measured intensity of the resulting axis.	Measured direction of the resulting axis in degrees.	Measured direction of the resulting axis.	Current in ampères in coil. I.	Current in ampères in coil. II.	Current in ampères in coil. III.	Direction in degrees of the resulting axis constructed according to the law of the parallelogram.	Current in ampères in coil. I.	Current in ampères in coil. II.	Measured direction of the resulting axis in degrees.	Measured intensity of the resulting axis.
— 3	177	— 3	120	3	133	0.0	+ 8.7	— 8.7	0	0.0	10.0	3	118
38	179	19	112	20	136	+ 1.7	+ 7.7	— 9.4	10	1.7	9.8	31	123
45	182	24	115	27	136	+ 3.4	+ 6.4	— 9.8	20	3.4	9.4	37	124
55	187	31	117	33	137	+ 5.0	+ 5.0	— 10.0	30	5.0	8.7	43	131
60	186	33	118	38	135	+ 6.4	+ 3.4	— 9.8	40	6.4	7.7	47	133
60	197	38	115	45	135	+ 7.7	+ 1.7	— 9.4	50	7.7	6.4	48	133
61	240	60	120	63	137	+ 8.7	0.0	— 8.7	60	8.7	5.0	53	132
60	282	81	115	78	137	+ 9.4	— 1.7	— 7.7	70	9.4	3.4	57	129
70	290	90	116	85	136	+ 9.8	— 3.4	— 6.4	80	9.8	1.7	63	125
70	294	92	119	92	140	+ 10.0	— 5.0	— 5.0	90	10.0	0.0	93	124
70	295	92	117	97	136	+ 9.8	— 6.4	— 3.4	100	....	....	..	....
79	297	98	115	103	136	+ 9.4	— 7.7	— 1.7	110	....	....	..	....
120	300	120	120	123	138	+ 8.7	— 8.7	— 0.0	120	....	....	..	....

* Galileo Ferraris. Rotationi elettrodinamiche prodotte per mezzo di correnti alternate. Torino, 1888.

iron ring, and are wound in such a way that every second bobbin has a low resistance and high inductance, and they rest vice versa. Each set of bobbins is connected in a series, and both sets in parallel.

Since the phase difference between the two currents connected in parallel can never reach 90 degrees, and in this case we cannot even freely choose the values of inductance and resistance, most likely a difference of 45 degrees will hardly be attained.

In that case the resulting field would be illustrated by case second, Fig. 1, that is, by a somewhat stretched ellipse.

A similar result is obtained in all motors in which only one current is used to obtain a rotary field, no matter whether the first or the second Ferraris method is employed, or a combination of both, as in another of Mr. Tesla's motors.

The question now arises to what extent the constancy of velocity and intensity is really attained in such motors, in which, according to the rule of the parallelogram, the necessary conditions are fulfilled. As far as I am aware Mr. Von Dolivo-Dobrowolsky has been the first to ventilate this question.* He assumes that the actual intensity of the resulting field in every moment is proportional to the sum of all ampère windings, and calculates the value of the fluctuations of intensity by simply adding up the ampère windings. However, this way of attacking the question can only lead to a very rough approximation, for if it were strictly correct no rotary field whatever could be produced, since its production is built up on the law of the parallelogram.

But, before we enter into the discussion of this question, I would like to insert a few words about the classification of the practical forms of rotary current motors. The first technical realization of the Ferraris principle, the Tesla motor, is substantially defined by the sketch, Fig. 3. Each of the two iron rings, *I* and *II*, is wound with four coils, which are connected together in the well-known way, making two perfectly independent equal circuits.

In Fig. 4 one of these two separate circuits is taken out and stretched out straight in order to show by the dotted line how the potential varies in its different parts. In the two coils, *I*, of the generator, the potential rises up steeply, falls off gradually in the conductor, f_1, then again falls off steeply in the two coils of the motor, and finally comes down gradually in the return wire, f_2, to its original value. When the circuit is perfectly insulated from earth the potentials in the two short connecting wires, v_1 and v_2, will be equal to the potential of the earth, but in all cases they will be equal. Therefore, if we connect the points, v_1 and v_2, no current will pass through the connection, nor will the whole system be in any way electrically disturbed. Moreover, since both circuits in the system are perfectly equal, it follows that we may also short circuit the two points, v_1, of the two systems in the generator, and the two points, v, of both systems in the motor, without introducing any electrical alteration whatever, and we obtain thereby the new system, Fig. 5. This deduction shows that between the older motor of Mr. Telsa and the newer forms recently designated as rotary current motors there is no real difference.

Recently it has been shown that the number of coils on one ring may be reduced to three, connections being made in the same way as in the Thomson-Houston armature. By dividing each one of these three coils into two halves and winding each half diametrically opposite the other, also according to the example of the Thomson-Houston armature, we finally arrive at a system which allows of driving a six-coil motor with three conductors carrying three simple alternating currents. Thus we obtain the three patterns of three-coil, four-coil and six-coil rotary current motors, Fig. 6, which no doubt will technically be the most important.

These three types were therefore subjected to a series of experiments by Messrs. Siemens and Halske, the results of which are laid down in the following:

An iron ring supplied with a continuous winding was taken from an experimental model, and the winding was divided into three, four and six equal parts respectively. Each part was excited by a perfectly constant continuous current, and the intensities of these exciting currents were so adjusted as to correspond to any phase of the three, four or six alternating currents, in which the resulting field was to be studied. In this way, for each phase of rotation, the resulting rotary field was made stationary, and the possibility attained of studying its shape by making diagrams of iron filings and its intensity and direction by corresponding measurements. Thus the diagrams, Fig. 7, were obtained, which show the actual variation of the rotary field in the three, four and six coil motor, when, according to the law of the parallelogram, the resulting field ought to appear advanced from 30° to 30°. The two concentric circles define the edges of the ring, the radial marks show the ends of the single coils. The arrow gives the direction of the resulting field as constructed according to the law of the parallelogram of forces.

The most interesting results are those shown in Fig. 7*a*, giving the rotary field of a three-coil motor. The resulting magnetic axis is mostly curved, except in those cases in which the excitation is quite symmetrical; and even then the lines of force appear contracted at one pole and spread out at the other (Fig. 7*a*, *I*. First coil: 0.0 ampères, second coil: + 8.7 ampères, third coil: — 8.7 ampères). But as soon as the excitation becomes asymmetrical, we obtain a curved magnetic axis, and besides greatly different intensities of the two poles (Fig. 7*a*, first coil: + 5.0 ampères, second coil: + 5.0 ampères, third coil: — 10.0 ampères), and so on.

The four-coil motor, Fig. 7*b*, gives a considerably better result. The magnetic axis is always straight, and both poles have equal intensities. The six-coil motor shows a still more equal resulting field, Fig. 7*c*.

In order to measure the intensities of the rotary field, a coil was hung in the centre of the ring, in such a way that its magnetic axis was perpendicular to the measured direction of the resulting magnetic axis of the ring. The coil was then excited by a constant continuous current, and was kept in its position by a spring. The torque of the spring served as a measure of the intensity. The horizontal component of the magnetism of the earth could be neglected in these measurements, because the ring surrounding the measuring coil effectually served as a magnetic screen.

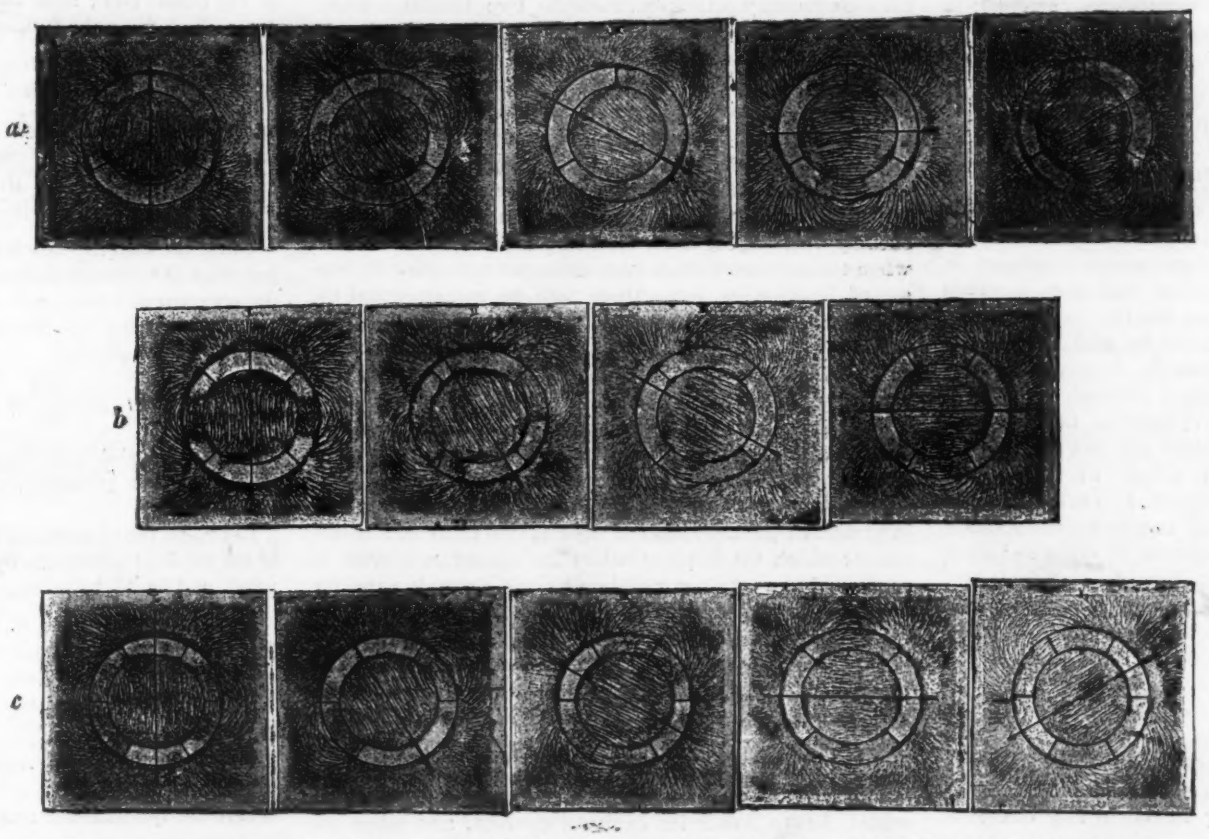


FIG. 7.—DU BOIS-REYMOND'S DEDUCTIONS AND EXPERIMENTS ON ROTARY CURRENTS.

The foregoing table gives the results obtained, but the diagrams, Figs. 8, 9, 10, contain them in a more convenient form. In the diagrams, Figs. 8 and 10, the results obtained are shown in the following way. For each measurement which shows a progress of a thirty-sixth part of one period against the last, and which, therefore, according to the law of the parallelograms, ought to show a progress of the resulting axis of 10°, a radius is drawn, the direction of which defines the actually measured direction of the resulting axis, while its length is proportional to the actually measured intensity of the resulting axis. In the three and six coil motor these measurements executed over one-third of the whole circumference are given; in the four-coil motor, those over one-fourth of the circumference are indicated.

The actually measured values are shown in the upper right hand part of the diagrams, Figs. 9 and 10. The other parts are obtained by simply repeating the same values slightly equalized.

The lengths of the radii are measured with an arbitrary unit, but with the same in all three diagrams, so that they may be compared. If the resulting axis obeyed the law of the parallelogram its intensity would be equal in all three, because the amplitude of the exciting currents was the same in all cases, namely, 10 ampères, and the sum of all windings was constant. However, we find the mean intensities in the three, four and six coil motor as 117 : 127 : 136.

The fluctuations of intensity are not appreciable in the six-coil motor. In the four-coil motor those fluctuations reach not quite 13 per cent. of their minimum value. In the three-coil motor the measurements of the intensity are not very valuable, because the resulting axis is mostly bent. The measurements were made in this case by taking the direction of the two poles singly and hanging the measuring coil in the mean direction equidistant from both. In the diagram, Fig. 8, therefore, only the mean value of the results so found is drawn.

The fluctuations of the angular velocity of the resulting axis are much larger than the fluctuations of the intensity in all three motors. The three-coil motor is especially interesting from this point of view because the two poles always move with different velocities. The diagram, Fig. 8, shows the movement of the resulting axis during one-half of a period. Since the same values theoretically must recur three times during one period, the mean value of the three corresponding measurements actually executed was three times repeated in the diagram. Thus perfect regularity was obtained, and a good illustration of the actual movement of the axis is arrived at.

Since the velocity of the poles themselves will chiefly influence the armature, it follows that this type is certainly not very advantageous. In the four-coil motor the variations of velocity are very much smaller, and still smaller in the six-coil type.

The question arises how far these results would be modified if the inside space of the ring were filled out by an armature, and what would be the further modifications if this armature rotated. However, we can assume with a reasonable show of probability that a constant field with a constant velocity would not be changed with regard to its constancy by adding an armature, provided that the saturation of the iron were not thereby essentially altered. Whether irregularities of intensity or velocity would be magnified or compensated by a rotating armature is difficult to decide. At any rate, these experiments show that though the law of the parallelogram of forces as accepted by Mr. Ferraris ought not to be trusted unconditionally, on the other hand the assumption that the resulting field varies as the sum of all ampère windings is still further from the truth.

* Kraftübertragung mittels Wechselströmen von verschiedener Phase (Drestrom) von M. von Dolivo-Dobrowolsky. Elecktrotechn. Zeitschr., 1891, pp. 149 and 161.

The Paris Electric Meter Competition.*

It will be remembered that the results of the first competition in electrical energy meters, instituted at Paris in 1889, were far from satisfactory, and that only 7,000 francs could be distributed in prizes out of the 20,000 francs which the Municipal Council placed at the disposal of the committee appointed to award the prizes. At the suggestion of this committee a second competition was instituted, for which the following programme was arranged:

Article 1.—A competition is opened for all inventors of electrical meters applicable to continuous currents alone, to alternating currents alone, or to both forms of current simultaneously.

Article 2.—The instruments submitted may be either electricity meters (*ampère-hours meters*) or energy meters (*watt-hours meters*).

Article 3.—The meter must be of such a nature that it can be read directly, and that the consumer can see for himself the quantity consumed.

Article 4.—The meters must be adapted to consumption on a small scale; the electricity meters must register from two-tenths of an ampère, the energy meters from 20 watts.

Article 5.—The meters, accompanied by an explanatory notice, must be delivered, sealed, at the Municipal Works at the Halles, between August 25 and 31, 1890. A receipt will be sent in due course.

Article 6.—The meters sent will be submitted to the decision of a committee composed of nine members, five being appointed by the Municipal Council, and four by the State.

Article 7.—The instruments will be subjected to comparative experiments bearing upon:

(*a*) Their accuracy throughout the scale of indications of which they are capable.

(*b*) Their practical value (as regards regularity of action, simplicity, cost, etc.).

(*c*) The energy expended in working them.

(*d*) The extent to which the distribution of the current is affected by their employment.

Article 8.—A sum of 13,000 francs will be distributed in prizes under the following conditions: 10,000 francs to the inventor who shall produce a meter giving complete satisfaction, and applicable to alternating currents as well as continuous currents.

If the meter should be applicable to one form of current

* From the *Electrical Review*, London.

only, the inventor will only be entitled to half the amount. Prizes amounting to 2,000 francs for meters that can be applied to both alternating and continuous currents, and to 1,000 francs for meters applicable to one form only, will be awarded to those inventors whose apparatus shows important progress in this branch of electricity.

The committee appointed on Dec. 9, 1890, with M. Huet, Sub-Director of Public Works for the city of Paris, as president, assembled for the first time on Dec. 11, and at once commenced the experiments, which proceeded almost without interruption until May 15, under the superintendence of a sub-committee composed of Messrs. Carpenter, Hospitalier, Mascart and Potier. At a final meeting held on May 30, 1891, the committee gave their unanimous approval to the decisions of the sub-committee, appointed M. Hospitalier reporter, and passed the following resolutions:

"The committee appointed to decide between the electrical energy meters entering into the competition, opened at the Hotel de Ville, is of opinion:

"That the Aron and Thomson meters fulfill all the conditions laid down in the second paragraph of Article 8 of the programme of the competition, and proposes to divide between them the prize of 10,000 francs to be awarded to the inventor who shall produce a meter giving complete satisfaction, and applicable to both alternating and continuous currents.

"The committee is of opinion that the instruments submitted by M. Frager and M. Marès show important progress, and propose to award three prizes of 1,000 francs each to these apparatus, as follows: M. Frager, 1,000 francs (alternating currents); M. Frager, 1,000 francs (continuous currents); M. Marès, 1,000 francs (continuous currents); in accordance with the fourth paragraph of Article 8."

Some Effects of Alternating Current Flow in Circuits Having Capacity and Self-Induction.*

BY DR. J. A. FLEMING.

21. In the foregoing paragraph no attempt has been made to enter into a discussion of the physical *modus operandi* of these condenser effects. We can easily construct, as has been frequently done, mechanical analogies, in which the elastic yielding of a spring and the inertia of a heavy body take the place of the capacity and inductance in the electric system. It is possible, however, to overrate the value of this mechanical parallel. It is probable that the actual physical operations taking place to produce these electrical effects are not adequately represented by a mechanical simile in which the inertia-like aspect of self-induction is exclusively regarded, although; of course, such mental representations have their use. Too much hypothesis is often as bad as too little in seeking to connect together observed facts and fundamental principles. We may regard a condenser, when subjected to periodic currents, as a non-dissipative impedance, if the term may be allowed, having also a negative self-induction. A condenser allows a flux of electricity to take place backward and forward through its dielectric, and, as far as alternating currents are concerned, it may be said to have a conductivity for electricity.

A condenser of capacity C, when traversed by periodic condenser currents of frequency n, acts in any circuit as equivalent to an impedance of magnitude $\frac{1}{Cp}$. It also acts as if it had a negative inductance equal to $\frac{1}{Cp^2}$, p, as usual, standing for $2\pi n$. By a negative inductance $\frac{1}{Cp}$ must be understood a power of nullifying positive inductance in a conductor in series with the condenser numerically to the amount $\frac{1}{Cp^2}$ henrys. Suppose, then, that a condenser of capacity C is placed in series with an inductive resistance L and resistance R, and a periodic potential difference equal to V_0 permitted to act on the two in series. The resultant inductance of the whole circuit is $L - \frac{1}{Cp^2}$, and the resultant impedance is

$$\sqrt{R^2 + \left(L - \frac{1}{Cp^2}\right)^2 p^2}.$$

Hence the current through the condenser is equal to

$$\frac{V_0}{\sqrt{R^2 + \left(L - \frac{1}{Cp^2}\right)^2 p^2}}.$$

If the potential difference of the two sides of the condenser is called V_1 and the equivalent impedance of the condenser is $\frac{1}{Cp}$ we may consider that the value of V_1 is obtained by taking the product of this so-called impedance of the condenser, $\frac{1}{Cp}$, and the value of the current flowing through it. Hence we have

$$V_1 = \frac{V_0}{\sqrt{R^2 + \left(L - \frac{1}{Cp^2}\right)^2 p^2}} \cdot \frac{1}{Cp},$$

but this is the same expression as that deduced before, for the ratio of V_1 and V_0. This is not to be considered as a demonstration of the equation, but only as showing how it may be regarded as being built up on the assumption that a condenser behaves toward alternating currents as an impedance causing fall of potential in a current passing through it, and capable of nullifying inductance in a circuit connected in series with it; and that such a view leads to an equation from which it is immediately seen that under some conditions V_1 must be greater than V_0.

22. Reference has been made recently in a paper read by Major Cardew to the difference of electric condition as regards potential above the earth which will exist between two insulated conductors, one of which entirely incloses the other, and which have different capacities, when they are connected to the terminals of an insulated transformer or alternator. In the case of a concentric cable the two copper members of which are insulated from each other, and the outer one insulated from a metallic sheath connected to earth, we have two insulated conductors, the interior one having capacity with reference to the outer, but not with reference to the earth, and the outer one having capacity both with reference to the inner and also with respect to the earth. This last capacity is generally, in cables as actually made, very much greater than the former.

In the case of the Ferranti trunk mains the inner-to-outer capacity is, as we have seen, about one-third of a microfarad per mile run of the cable. Calculating from the measured dimensions and from the specific inductive capacity of the insulating material as deduced from the inner-to-outer capacity, the magnitude of the outer-to-earth capacity I find to be about ten times greater, or more than three microfarads per mile. It follows immediately, from elementary principles, that the two insulated members of such a concentric cable will, when connected respectively to the terminals of an insulated transformer or dynamo, always be brought into such a condition that the outer member is at zero potential as regards the earth, and that the full difference of potential which the transformer or dynamo is capable of making will subsist between the outer and inner member of the cable. This is true only when the outer member entirely incloses the inner member; but it is also true that when the two conductors have different capacities by reason of position or form there will be an electrical inequality between them, in that the difference of potential between each conductor and the earth will not be the same. The conductor which has the larger capacity will have the lesser potential with respect to the earth, provided always that both conductors attached to the poles of the generator or transformer are insulated throughout their length.

23. The condenser effect we have been considering, and in particular the alteration of the change ratio of a transformer which takes place when its secondary circuit is connected to a conductor system having a certain capacity in relation to the inductance of that secondary circuit, is found to operate in many curious ways in the practical use of such combinations. For instance, if a pair of alternators separately excited are working in parallel on an omnibus main leading to a conductor system of no sensible capacity, then we know very well that if the dynamos are synchronized, and contributing equally to the outgoing current, the method adopted to take one dynamo out of circuit would be to lower its exciting current, and when its outgoing current fell to zero to sever its connection with the omnibus main. If, however, the alternators are working through step-up transformers, and into a conductor system consisting of concentric cable, it is found by experience that the exciting current of the dynamo to be taken out must be raised, and not lowered, in order to bring it into a condition in which it can be cut off from the omnibus main without dangerous sparking at the switch; and, conversely, in putting it into parallel the incoming alternator has to be excited to a lower electromotive force than is necessary to maintain the standard potential difference at the terminals of the step-up transformer before putting it into connection with the omnibus main. This is obviously due to the fact that the change ratio of the step-up transformer is altered by the very act of putting it into connection with the conductor system, and hence the excitation of the alternator at the moment of making or breaking connection with the main must be such as will bring the potential difference of the free secondary terminals of the step-up transformer to a value equal to the potential difference of the two points on the conductor having capacity to which they are about to be connected, or from which they have just been severed; and when the connection of the alternator is made, the excitation can be altered to divide the load on the machines properly. This, of course, would not be the case if high tension alternators of very small inductance were set to work in parallel on such a concentric conductor system. In this case the condenser effect is practically nothing, and the behavior of the machines on going into or out of parallel would present nothing unusual.

24. In the cases briefly discussed above, the cables, whether concentric or simple, have been found to act as single condensers substituted for them would act; and in the experiments described no progressive rise of pressure from one end to the other of a cable possessing capacity was found to exist.

It is, however, quite possible for self-induction, resistance and capacity to be so combined together in one conductor that the action of an impressed periodic electromotive force at one end will create a progressive rise of mean pressure along the cable when the far end is insulated. The complete theory of such effect is rather too long to discuss here. The propagation of a simple periodic current and the action of a simple periodic electromotive force upon a concentric cable has been very fully discussed by Mr. Oliver Heaviside in an able series of papers on "The Self-Induction of Wires," published in the *Philosophical Magazine* for 1886 and 1887. A very brief summary of the results is all that can be given here: but those desirous of further information may be particularly referred to the *Philosophical Magazine*, vol. XXIII., January, 1887, page 18, in which paper Mr. Heaviside deals with the problem which is particularly the practical one—viz., a concentric cable having at one end a transmitting apparatus, such as a telephone, alternator, or a step-up transformer, and at the other a receiving instrument, such as another telephone or a step-down transformer.

We have, then, a sending instrument having resistance and inductance; a cable having resistance, capacity and inductance; and a receiver having also resistance and inductance. Given the electromotive force in the transmitter, the problem is to find the current in the receiver.

Consider first, a very long concentric cable having inductance L, resistance R, and capacity C, all per unit of length. Fix attention upon a small length of the cable, δx, and suppose that the current flowing into this element at any instant is i, and the current flowing out of it is $i - \delta i$ when some electromotive force acts at one end of the cable. Also let v be the potential of the inner conductor at the one end of the element of length, δx, and $v - \delta v$ be the potential at the other end; then the current i at any instant t is determined from the fundamental equation.

$$L\delta x \frac{di}{dt} + R\delta x i = \delta v, \qquad (33)$$

and the current and potential are connected by another relation,

$$\frac{di}{dx} = C\frac{dv}{dt}, \qquad (34)$$

because the current flowing out of the element of length is less than the current flowing into the element by the condenser current taken up in the element.

Differentiating (34), and substituting in (33), we arrive easily at the equation,

$$LC\frac{d^2v}{dt^2} + RC\frac{dv}{dt} = \frac{d^2v}{dx^2}. \qquad (35)$$

This differential equation gives us the means of determining the potential, v, at any time and place in the cable.

Let v_0 be the electromotive force at the origin or the end of the cable at which the dynamo or electromotor is applied, and let V_0 be its maximum value—such that,

$$v_0 = V_0 \sin pt;$$

then, if the cable is infinite in length, the solution of the equation (35) can be obtained, and the potential v at any distance x from the origin, and any time, is easily shown to be given by

$$v = V_0 e^{-Px} \sin(pt - Qx),$$

where the quantities P and Q are:

$$P = \pm\left\{\frac{pC}{2}\left(\sqrt{R^2 + p^2L^2} - Lp\right)\right\}^{\frac{1}{2}}.$$

and

$$Q = \pm\left\{\frac{pC}{2}\left(\sqrt{R^2 + p^2L^2} + Lp\right)\right\}^{\frac{1}{2}}.$$

For the Ferranti trunk mains the values of these quantities have been calculated in Section 14.

If the cable is not infinite in length, but has a finite length l, then two cases may be considered—(i.) when the cable is short circuited at the far end, and (ii.) when its two members are insulated or open circuited at the far end.

Taking the first case of a concentric cable of length l, short circuited at the far end and attached to an alternator of negligible inductance and resistance at the other, Mr. Heaviside has shown how the potential at any distance, x, from the machine can be obtained, and also the current flowing through an ammeter placed at any point in the cable. If V_0 is the maximum value of the periodic electromotive force applied at the dynamo end, and v is the potential at any time, t, and any distance, x, from the dynamo end, then he gives the value of v as

$$v = V_0 e^{-Px}\sin(pt - Qx) + V_0 \frac{e^{Px}\sin(pt + \theta_2 + Qx)}{e^{Pl}(e^{2Pl} + e^{-2Pl} - 2\cos 2Ql)^{\frac{1}{2}}} - V_0 \frac{e^{-Px}\sin(pt + \theta_2 - Qx)}{e^{Pl}(e^{2Pl} + e^{-2Pl} - 2\cos 2Ql)^{\frac{1}{2}}}$$

(see *Phil. Mag.*, Vol. XXII., September, 1886, p. 284.)

It can be shown from the above that the ratio of the maximum value V of the potential at any distance x from the origin to the potential at the origin V_0, is given by the relation,

$$\left(\frac{V}{V_0}\right) = \frac{e^{2P(l-x)} + e^{-2P(l-x)} - 2\cos 2Q(l-x)}{e^{2Pl} + e^{-2Pl} - 2\cos 2Ql}. \qquad (36)$$

In the above equations P and Q stand for the functions of resistance, inductance, and capacity given above in section 14, and e is the Napierian base.

The equation (36) enables the pressure at any point in the cable, as given by a voltmeter, to be predetermined

* Concluded from THE ELECTRICAL WORLD, June 20, 1891.

from the pressure at the origin. The current flowing through a low-resistance ammeter placed at any point in the cable can also be deduced from the equation (36), and its maximum value, I, is shown by Mr. Heaviside to be given by the equation,

$$I^2 = \frac{V_0^2\, C\, p}{\sqrt{R^2 + p^2 l^2}} \frac{e^{2P(l-x)} + e^{-2P(l-x)} + 2\cos 2Q(l-x)}{e^{2Pl} + e^{-2Pl} - 2\cos 2Ql}. \quad (37)$$

This gives us the value of the dynamometer reading at any point in the cable. It shows us that if l is great enough the current flowing through an ammeter placed at the distant end of the cable would be zero.

Suppose, next, that the distant end of the table is open-circuited, and that an electromotive force, of which the maximum value is V_0, acts at the home end. It is then possible to prove that under these circumstances the ratio of the maximum value, V, of the potential at any distance, x, from the origin to the maximum value of the potential at the origin, is given by the equation,

$$\left(\frac{V}{V_0}\right)^2 = \frac{e^{2P(l-x)} + e^{-2P(l-x)} + 2\cos 2Q(l-x)}{e^{2Pl} + e^{-2Pl} + 2\cos 2Ql}. \quad (38)$$

If $x = l$—that is, if we consider the potential at the far end, the numerator of the right hand side becomes equal to 4, and hence if the denominator is numerically less than 4 for any given table—it indicates that a progressive rise in pressure along such table will take place from the machine end to the free or insulated end.

In a very able paper in the *Philosophical Magazine* for January, 1887, page 21, Mr. Heaviside has attacked the general problem of calculating the current flowing through a transformer at the far end of a concentric cable when an alternator or transformer giving a periodic electromotive force of maximum V_0 is placed at the other. The paper is not an easy one to read, and was probably still harder to write. Some of the general results are, very briefly, as follows: If L_0 and R_0 are the total inductance and resistance of the transmitter, whether alternator or transformer, and L_1 and R_1 the same quantities for the receiver, and L, R and C the inductance, resistance and capacity per unit of length of the cable, and V_0 the maximum value of the impressed electromotive force at the transmitter, and C_0 the maximum value of the current through the receiver, then

$$C_0 = 2V_0 \frac{C\, p}{(R^2 + p^2 L^2)^{\frac{1}{2}}}$$

$$\left[G_1 G_0\, e^{2Pl} + H_1 H_0\, e^{-2Pl} - 2(G_1 G_0 H_1 H_0)^{\frac{1}{2}} \cos 2(Q l + \theta)\right]^{\frac{1}{2}}$$

where G_1, G_0, H_1, H_0, and θ are complicated functions of the resistances and inductances of the receiver and transmitter, and which have the values,

$$G_0 = 1 + (P^2 + Q^2)\left(\frac{I_0}{I}\right)^2 + (2PR + 2QpL)R_0 + 2PLp^2 - 2QpR)L_0;$$

$$H_0 = 1 + (P^2 + Q^2)\left(\frac{I_0}{I}\right) + (2PR + 2QpL)R_0 - (2PLp^2 - 2QpR)L_0;$$

and similarly for H_1 and G_1.

I_0, I and I_1 are the impedances of the transmitter, cable and receiver; and the quantities P and Q have the values given in Section 14.

The quantity θ is an angle which is determined from the expression,

$$\tan 2\theta = \frac{2(Ab - aB)}{A^2 + B^2 - (a^2 - b^2)},$$

where

$$Ab - aB = (R_0 + Q_1)(RQ - LpP) + (L_0 + L_1)p(RP + LpQ) - (R_0 I_1^2 + R_1 I_0^2) CpP - (L_0 I_1^2 - L_1 I_0^2)p^2 CQ;$$

$$A^2 + B^2 = I^2 + C^2 p^2 I_0^2 I_1^2 - 2(R_0 R_1 - L_0 L_1 p^2) LCp^2 - 2(R_1 L_0 + R_0 L_1)p^2 RC;$$

$$a^2 + b^2 = (P^2 + Q^2)[(R_0 + R_1)^2 + p^2(L_0 + L_1)^2].$$

The question whether the mean pressure at the receiver is greater than the mean pressure at the sending end, or less, will in general depend upon the sign of tan 2θ.

The quantities G_0 and H_0 become equal to unity when the inductance and resistance of the sending instrument are zero or very small.

The practical deduction which may be made from the above investigation is that, when the alternator at the sending end has very small resistance and inductance, the pressure at the receiving end of the cable will be less than the pressure at the transmitting end, for almost any cases which occur in practice; but this is not always the case when the transmitting instrument has a sensible inductance. We may then have conditions under which there is a progressive rise of pressure from the sending to the receiving end.

The time at disposal has not permitted me to do more than sketch out the general results of such investigations as have been made on the propagation of periodic currents through conductors having sensible capacity and inductance. These investigations need to be brought into further comparison with the results of experience, in order that we may see how far they agree with observed facts, and how far they can be trusted as a guide in predicting the results of the application of known electromotive forces to conductor systems in which the capacity and inductance can be predetermined.

Electrical Cable Testing.

BY HENRY W. FISHER.

In preparing these papers it has been the object of the writer to use as few and as simple mathematical formulæ as is consistent with good work. He fully realizes that many of us, who are able to follow ordinary mathematical discussions, pay very little attention to them as they are met in electrical papers. Can we then censure the many thousands of earnest readers who look on articles that contain even a moderate amount of mathematics with feelings akin to those of disgust? It has been my pleasure and privilege to meet very many bright men in practical work, who never can be induced to make use of algebraic equations, simply because such methods of reasoning do not appear to belong to their line of work. Let these conceive of a few letters being used momentarily to represent a few known or unknown quantities. Most of these quantities will be determined by observation, and then all that remains to be done will be to place them in their respective places in the formula and then reduce to find the desired numerical result.

I presuppose the reader to be familiar with the uses of the Thomson reflecting galvanometer and Wheatstone's bridge, descriptions of which may be found in almost any of the simple works on electricity.

Many of the methods used are old, but occasionally, where necessity demands it, special formulæ have been worked out to fit the case in hand.

Preparatory to describing the methods of locating faults, it will be necessary to outline some of the ways by which we determine the working condition of a cable and measure insulation, resistance and electrostatic capacity. In advance of this, however, the writer will mention some of the difficulties that arise in the practical use of the mirror galvanometer and Wheatstone's bridge.

In buildings where there is much vibration the galvanometer should be suspended with springs, and in addition to this it will often be found necessary to weight the galvanometer with 20 to 50 pounds. By so doing the writer has obtained most satisfactory results. In a factory where the vibration was excessive, so that the spot of light would move through 50 or 100 divisions incessantly if the galvanometer was set up in the ordinary manner, the vibration was reduced to scarcely one-half a division at its worst, and nothing at its best, by suspending as above described. A convenient portable suspension frame can be made of four brass tubes that screw or fasten by a spring catch to a top and bottom rectangular frame. The bottom frame should be much larger than the top and should be provided with suitable legs. To the top frame four springs capable of sustaining the weight of the galvanometer are attached. These may extend all the way to the galvanometer, or, better, springs about one foot long may be attached to the galvanometer and to the top frame, the upper and lower springs being connected by tubular cotton braid. The galvanometer should be placed on a square board with four brass rods passing through near the corners and extending above the middle of the galvanometer; to these four rods the springs are attached. The galvanometer can be weighted by fastening the ends of these rods to a square slab of lead. A long suspension is desirable. Four delicate springs may extend from the base of the galvanometer to the brass tubes or to the ground frame. These tend to prevent the galvanometer from oscillating as a pendulum. A better plan is to fasten rigidly some horizontal and vertical paddles to the bottom of the galvanometer and place these in a vessel containing oil. By having sufficient resisting surface and distributing it so as to oppose every movement of the galvanometer the vibration of the needle may be greatly reduced. The controlling magnet can be attached to an arm that is fastened to one or more of the brass tubes. With such an arrangement excellent results can be obtained.

Another cause of trouble and error are the false deflections imparted to the needle by the movement of iron near the galvanometer. The passing of a street car will often so affect the magnetic field in the neighborhood of the galvanometer as to produce a considerable movement of the spot of light. This is very annoying, for not infrequently readings have to be taken at definite times, and hence the observer is obliged to make several tests and take the mean of the readings. There are three ways to partially overcome this difficulty:

1. Use an astatic combination attached to the mirror bar. If the two sets of needles with opposite polarities are nearly balanced they will be affected about equally by change of magnetic field due to movement of iron at a distance, and hence as the turning forces oppose each other there will be no appreciable movement of the mirror.

2. Reduce the sensitiveness of the galvanometer by placing the controlling magnet in such a position that the needle will not be noticeably affected by these extraneous disturbances. However, as this is done at the expense of sensitiveness of the galvanometer, it will be necessary to use a much larger battery in making insulation and capacity tests.

3. Provide a magnetic shield to surround the galvanometer as completely as possible. The writer has used one quite successfully. A tin vessel was made of such a shape as to admit of containing soft iron filings enough to form a layer one-half inch thick almost entirely around the galvanometer. Of course, a circular hole, just large enough so as not to interfere with the reflected spot of light, was left in front of the mirror.

Many if not most of the galvanometers employed in practical work are of such construction that short fibres have to be used for suspending the mirror and needle. This is often a decided disadvantage on account of the spot of light failing to return immediately to its zero or starting point. And hence it is difficult to tell what the true deflection is. This peculiarity is apparent more or less in all forms of silk fibres, but may not introduce a noticeable error where long fibres of unspun silk are used. Of late quartz fibres are coming into favor, and they are claimed to possess none of the unsatisfactory qualities of silk. The writer has made and used them, and he cannot speak too highly of their merits. In suspending a galvanometer with such a fibre the greatest care must be exercised. While they are exceedingly tough when subjected to longitudinal stress, they nevertheless break far too easily when bent sharply. They can be readily secured to the needle by means of a pasty mixture of alcohol and shellac, the alcohol being afterward removed by the application of a hot iron. Some of the fibres used by the writer were so small as to be with difficulty visible to the naked eye even when placed upon dark wood immediately beneath the light of an incandescent lamp. With these the most satisfactory results were obtained. The fibre in use was scarcel three-quarters of any inch long and yet, even when the galvanometer was made exceedingly sensitive and when the needle was deflected through a considerable angle, the spot of light invariably returned to zero. With silk placed under like conditions no such good results were obtained.

These quartz fibres when once suspended seem to stand a great deal of rough usage, which indicates that they can be used successfully in practical work. They are, however, more sensitive to vibrations than silk fibres, but the error introduced from this cause will scarcely be as great as that due to the set in silk.

The galvanometer should, of course, be kept well insulated, which means that it should be placed in a dry room. Care should be taken never to subject it directly to much electrical pressure, as the result might be a burning of one or more of the coils or a demagnetizing of the needle.

In measuring resistance with the Wheatstone bridge care must be taken not to overheat the coils by using too much battery. Six cells will be ample for most purposes.

FIRST.—ORDINARY OUTSIDE TESTING.

It is generally known now that a magneto bell cannot be used for testing underground wires, as the static charge between the conductor and ground is often sufficient to ring the bell. In the hands of experienced persons telephones can be used easily and successfully. One great advantage they possess is that after having determined the condition of a cable, directions as to what must be done next at the other end can be sent by means of the telephone. In laying cables it is a common practice to test them every section or every few sections. These tests consist in determining whether any of the wires are grounded or crossed or broken.

A telephone or a small current detector galvanometer can be used for this purpose.

Leaks or Grounds.—In testing for leaks or grounds, with the outfit above described, the cable wires should be opened at the point where they connect to the air lines and the test applied at the other end of the cable. One pole of the testing battery is grounded, the other connected to one post of the galvanometer; a short piece of insulated wire, attached to the other post of the galvanometer, is then touched successively to the bared ends of the cable conductors, and any one causing a permanent deflection of the galvanometer needle is faulty. A chloride of silver battery of at least 50 cells should be used for this purpose. Horizontal galvanometers that will show a leak of over one megohm with 50 cells of battery can be purchased at electrical supply stores.

Crosses.—In testing for crosses, bunch all the wires and connect them to one end of the testing circuit; then remove, one by one, the wires bunched, touching each successively to the other end of the testing circuit. A sudden deflection of the galvanometer needle indicates that the wire touched is crossed with one of the bunched wires. Mark this crossed wire and place it back with the untested wires, keeping it there till all have been tested. Before this is done, however, the one that is crossed with it will be identified. Care must be taken to see that none of the wires are in contact with each other or the lead cover at the other end of the cable.

Identifying Wires Without Cutting.—It is frequently necessary to identify certain wires in a joint or cable, so that they may be brought out and connected to a subsidiary cable. To do this, without cutting the wire or insulation, ground the desired wires at one end of the cable, being careful that all the other wires are separated and free from grounds at both ends; remove the lead from the joint or cable, and heat the insulated wires by a torch, furnace or hot insulating compound; as soon as the surplus insulation has been melted off, so that the individual wires can be separated, test for the grounded wires by means of a galvanometer and battery, as above described, making connection with each wire by means of a needle or other pointed instrument that can be used to pierce through the insulating covering.

Continuity.—To test for broken wires the conductors should all be grounded at one end and the test applied at the other end, as explained under "Leaks or Grounds"; but in this case the deflection obtained from each wire is evidence that it is not broken.

SECOND.—INSULATION RESISTANCE TESTS.

The term "insulation resistance" signifies the resistance offered to the passage of electricity by a so-called non conducting substance. Thus when we speak of an electric light cable having an insulation resistance of 4,000 megohms per mile, we mean that the resistance between the conductor and earth of one mile of this cable is 4,000 megohms. It will readily be seen that in order to operate an electric circuit economically and safely the insulation resistance must be good, and especially is this true of underground electric cables where the conductor is so close to earth. Very often an apparently insignificant defect in the insulation resistance will become rapidly worse through electrolytic action on the passage of the current between the conductor and ground. Hence it is extremely important not to let any moisture enter the cable either in the joints or in the terminal boxes.

The necessary electrical apparatus for making insulation resistance tests is: A Thomson reflecting galvanometer with its scale, lamp and shunt, a one-tenth megohm resistance box, a chloride of silver battery of not less than 50 cells (preferably 100), and an appropriate switch.

The first step to take will be to secure a room or basement (preferably the latter) at a convenient distance from either end of the cable. Run two highly insulated wires, and connect one to the lead cover, the other to the conductor whose insulation resistance is required, the remaining conductors, if any, being connected to the lead cover.

Set up the instruments on a table, and make the connections as illustrated in Fig. 1, where R is the one-tenth megohm box or rheostat, G the galvanometer, F its shunt, B the battery, and S a switch.

The first step will be to determine the "galvanometer constant," or, in other words, the equivalent deflection were all the battery current allowed to pass through one megohm and the galvanometer in series. Such a deflection cannot be read in practice, hence we make use of the shunt, a device that enables us to permit only $\frac{1}{10}$, $\frac{1}{100}$ or $\frac{1}{1000}$ of the total current to pass through the galvanometer at will. Inserting the plug in the $\frac{1}{9}$, $\frac{1}{99}$ and $\frac{1}{999}$ shunts permits respectively $\frac{1}{10}$, $\frac{1}{100}$ and $\frac{1}{1000}$ of the total current to pass through the galvanometer, and 10, 100 and 1,000 are the multiplying values of these shunts. It will be understood, of course, that the deflections are proportional to the amount of current that passes through the galvanometer, and hence we know that if we used the $\frac{1}{999}$ shunt and get a deflection of 200 we have obtained a deflection of $200 \times 1{,}000 = 200{,}000$, had we allowed all the current to pass through the galvanometer and could we measure such an enormous deflection.

To find the constant of galvanometer, therefore, multiply the deflection as read by the multiplying value of the shunt used and by the resistance of the resistance box expressed in megohms.

Place the switch S in the position represented by dotted lines, insert the plug in the $\frac{1}{999}$ shunt and close the battery switch b, open the short circuit key c of the shunt f, read the deflection. If it is less than $\frac{1}{10}$ the reading capacity of the scale the $\frac{1}{10}$ shunt can be used. Problem—By using the $\frac{1}{999}$ shunt a deflection of 584 through $\frac{1}{10}$ of a megohm was obtained; what is the galvanometer constant? Answer—$584 \times 1{,}000 \times \frac{1}{10} = 58{,}400$.

The next step is to place the switches in the position shown full in the figure, open the shunt key and if no deflection is observable remove the plug from the $\frac{1}{999}$ shunt, so that all the current can go through the galvanometer. If the spot of light goes off the scale use the shunt that will give the largest readable deflection, and then reduce to the equivalent deflection by multiplying the deflection as read by the multiplying power of the shunt that was used. The deflection should not be read till the cable has been allowed about one minute to electrify.

Next disconnect the lead wire from the conductor of the cable and proceed as above in order to see whether any of the deflection obtained was due to a fault on the lead wires. If any deflection is observable the deflection as read when the cable conductor was connected must be diminished by the amount of this deflection.

The absolute insulation resistance is then found by dividing the constant of the galvanometer by the deflection due to the cable, and the insulation resistance per mile is obtained by multiplying the absolute insulation resistance by the length of the cable, expressed in miles. Problem—With a constant of galvanometer = 58,400, a total deflection = 21.5, a deflection due to the leads = 1.5; what is the absolute insulation resistance and what is the insulation resistance per mile, the cable being 1.5 miles long?

$$\text{Absolute insulation resist.} = \frac{58{,}400}{20} = 2{,}920 \text{ megohms;}$$

insulation resist. per mile $= 2{,}920 \times 1.5 = 4{,}380$ megohms.

A large deflection, gradually decreasing in value, is generally an indication of polarization, and when this is the case it will be found that water has entered the cable at the ends or in the joints or at some point where the lead has been torn off by careless handling.

3. *Measuring Electrostatic Capacity.*—In addition to the instruments already mentioned under "Insulation Resistance Tests" a condenser and a discharging key will be needed. Not infrequently the shunt is used in measuring the throw or sudden impulse imparted to the needle when this throw is so large that it cannot be measured with all the current passing through the galvanometer. Then the throw as read is multiplied by the multiplying power of the particular shunt used. When accurate results are required the shunt should never be used in this manner, for on account of the self-induction in the coils the multiplying powers, which were correct for making insulation resistance tests, are not to be relied upon in measuring electrostatic capacity.

The best way to get accurate results is to make use of a multiple series condenser and plug in a capacity that will

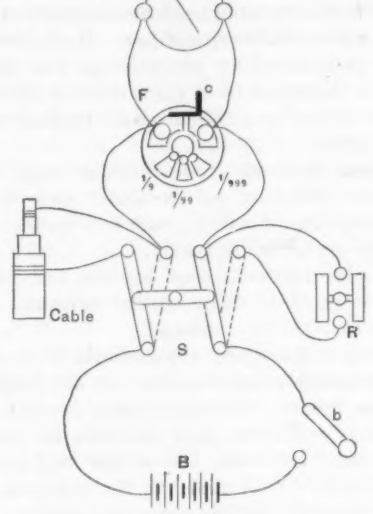


Fig. 1.—Arrangement of Electrical Testing Apparatus.

be about equal to that of the cable. Then enough battery can be used to give a large throw, and, as the two throws are nearly equal, the results obtained will be very accurate.

When a multiple series condenser is not accessible the following method can be adopted: Determine accurately the multiplying power of the $\frac{1}{9}$ shunt by comparing the throws with and without the shunt in multiple with the galvanometer. Different amounts of battery should be used in order that a fair mean can be obtained. Similarly the $\frac{1}{9}$ and $\frac{1}{99}$ shunt can be compared, but the latter will never be needed in ordinary land practice. This method is not so accurate as the first, but its percentage of error will often be less than that of the condenser.

Still another method is to use a very long scale and to calibrate it so that the true relations existing between different throws can be determined. This is effected by taking the throw from one cell, then from another, then from the first and second in series, and so on till enough cells are used to

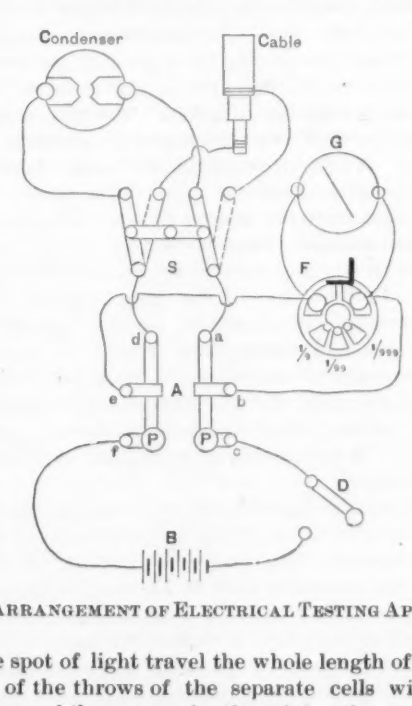


Fig. 2.—Arrangement of Electrical Testing Apparatus.

make the spot of light travel the whole length of the scale. The sum of the throws of the separate cells will be the true throw, while an examination of the throw with the same cells in series will show how much it departs from its correct value. By the use of curves the correct value for any deflection can readily be obtained. Unless special care is taken to set up the galvanometer and scale in the same relative positions this method should only be adopted in factories and laboratories where the galvanometer and scale are stationary.

The shunt, however, can most effectively be used in checking the vibrations of the needle after an impulse has been imparted to it. As it returns to its starting point after the throw, press down and release the discharging key suddenly, then use the shunts one after another, pressing and releasing the key till the needle has come to rest.

Fig. 2 shows the general arrangement of the apparatus. G is the galvanometer, F its shunt, A is the discharging key, S a switch, B the battery and D the battery switch. When the discharging key A is in repose we have electrical connection between a and b and between d and e. Upon pressing down firmly the buttons P P, a is connected electrically with c, and d with f. The condenser and the cable can thus be charged at will by means of the battery B and the switch S.

The number of cells used will depend upon the method of testing that is adopted; from six to ten will generally be found sufficient.

As in the case of insulation resistance tests, connection should be made to one wire free from all the others, and to the others grounded to the lead of the cable.

From an examination of the connections in Fig. 2 it will readily be seen that upon releasing the buttons P P after they have been held down to charge the cable or condenser the electrostatic charge passes through the galvanometer. This sudden passage of the current through the galvanometer coils causes a sudden movement of the needle, called in practice the throw; and it is by a comparison of the throw made by the discharge from a condenser of known value with the throw of the cable that the electrostatic capacity of the latter is figured.

Where only approximately correct results are desired the shunt may be used, and in such a case proceed as follows: Place the switch S so as to charge the condenser, and if the spot of light goes off the scale with no shunt put the plug in that shunt which will give the largest readable deflection; hold down firmly the buttons P P for about 15 seconds and then release them suddenly, noting the throw imparted to the needle; in like manner read the throw from the cable after it has been charged.

Where shunts are used the throw must be multiplied by 10 for the $\frac{1}{9}$ shunt, 100 for the $\frac{1}{99}$ shunt, and 1,000 for the $\frac{1}{999}$ shunt.

Letting t = the throw produced by the charge from the condenser, t^1 = the throw produced by the charge from the cable, and K = the electrostatic capacity of the condenser in microfarads, then the electrostatic capacity of the cable in microfarads $= \frac{t^1 \times K}{t}$, and the capacity per mile is obtained by dividing this result by the length of the cable in miles.

If the multiple series condenser is used, measure first the throw from the cable, using, of course, sufficient battery to give a reasonably large deflection; then plug in enough capacity in the condenser to give a throw about equal to that of the cable. From both these throws and the capacity used the electrostatic capacity of the cable is figured as above described.

Example:

Throw on condenser = 312.
" " cable = 283.5
Electrostatic capacity of condenser = .3203 microfarad.
Electrostatic capacity of cable $= \frac{.3203 \times 283.5}{312}$
$= .2910$ microfarad.
Length of cable = 9,018 feet, or 1.720 miles.
Electrostatic capacity of cable per mile $= \frac{.2910}{1.708}$
$= .170$ microfarad.

Experiments on Foucault Currents, etc., in Dynamos.*

BY R. H. HOUSMAN.

The following experiments have been made to test the accuracy of the so-called assumptions on which the validity of the graphic method of analyzing armature losses depends:

Two Chamberlain and Hookham five-kilowatt dynamos, identical in every respect, running at high speed and low induction density in the armature (1,440 revolutions and $B = 12{,}000$), were chosen, so that friction might constitute a large fraction of the total losses measured. The bearings were 1¾ inches diameter at the pulley end, and 1¼ inches at the commutator end; the commutators were 4 inches diameter, with two pair of 1¼-inch brushes on each; the armature contained about 3,400 cc. of iron in the form of plates .017 inch thick, with about 10 per cent. insulation.

The two machines were coupled together by a simple flexible coupling, the friction of which was quite negligible. Then, by measuring the power supplied to machine I, the different losses in machine II were determined by difference with fields excited and unexcited and brushes on end off. Bearing friction of machine II was determined by difference when coupled and uncoupled to machine I, but in this case a small correction was necessary for the slight vibration caused by the two shafts not being exactly in line. The power wasted from this cause was found to be proportional to the square of the speed, and was represented by .15 ampère at 120 volts = 18 watts. The loss due to vibration has often been noticed before, especially on a boarded floor with an armature a little out of balance.

The experiments consisted of five distinct sets of measurements:

(A) Machine I, with one pair of brushes only.
(B) Machines I and II coupled, only I excited with one pair of brushes.
(C) Machines I and II coupled, only I excited, four pairs of brushes on.
(D) Machines I and II coupled, both excited, only one pair of brushes on D.
(E) Machines I and II coupled, both excited, four pairs of brushes on.

It must be observed that the figures deduced for zero volts are those which would be observed if the same law

*From *The Electrician*, London.

held good right down to zero, as actually does hold from 120 volts to 40 volts, or from 1,440 revolutions to 480 revolutions, which represents about the range of speed used in practice.

Brush Friction (three pairs).

From (C) — (B) at 0 volts	.52	ampère.
From (E) — (D) at 0 volts	.50	"
Mean at 0 volts	.51	"
From (C) — (B) at 120 volts	.45	"
From (E) — (D) at 120 volts	.43	"
Mean at 120 volts	.44	"

Hysteresis and Foucault Currents.

Hysteresis from (D) — (B) at 0 volts	.45	ampère.
Hysteresis from (E) — (C) at 0 volts	.45	"
Mean hysteresis	.45	"
	Amps.	
Hysteresis + Foucault currents [from (D) — (B) at 120 volts]	1.22	
Hysteresis + Foucault currents [from (E) — (C) at 120 volts]	1.20	
Mean hysteresis + Foucault currents, at 120 volts =	1.21	

∴ Foucault currents at 120 volts = 1.21 — .45 = .76 ampère.

Bearing Friction.

Machine II from (B) — (A) at 0 volts	= .88	ampère.
Machine I from (A) — other losses at 0 volts	= 1.00	"
Mean bearing friction at 0 volts	= .91	"
Machine II from (B) — (A) at 120 volts — coupling = 1.06 — .15	= .91	"
Machine I from (A) — other losses at 120 volts	= .96	"
Mean bearing friction at 120 volts	= .935	"

The figures for friction of bearings of machine I assume that hysteresis and Foucault currents are the same in both machines.

It appears from the above experiments that, within the limits of accuracy attainable in a shop experiment, bearing friction is constant, while brush friction *decreases* as the speed increases.

Bearing friction may be measured approximately without a second motor by running the machine to be tested as a *shunt* motor on very low volts, so that the magnets do not approach saturation. Under these circumstances, as is well known, the speed is independent of the E. M. F. at the terminals, and the power absorbed is almost constant. By calculating for hysteresis and correcting for Foucault currents from the diagram, a very close approximation for the loss in bearing friction may be obtained.

The Riverside Park Electric Railway.

The Riverside Park Electric Company formally opened their electric railway line at Sioux City, Ia., last week, displacing the steam dummies with six Westinghouse motor cars. The former did not afford desirable and economical transit service between the city and Riverside Park—destined to be one of the most beautiful summer resorts in the West—as well as to the intervening section, which is rapidly filling up with beautiful residences.

The power house is located at the edge of the park near the confluence of the Big Sioux with the Missouri River, within 100 yards of that historical landmark, the old Brughier cabin, and at the foot of the hill at the apex of which rest the remains of the old Indian chief War Eagle. The station is a solidly constructed brick building 62 × 95 feet, divided into two rooms with fire wall between. One room contains two Wicks tubular steel boilers, 60 inch × 16 feet, having 44 four-inch tubes; the base of stack, which is 113 feet in height, 42 inches in diameter and built of No. 10 and 12 iron; the Worthington pump; a 250 h. p. Kroeschell heater, two Hancock inspirators, and four sets of steam loops. These last were devised by Messrs. Westinghouse, Church, Kerr & Co., who secured the contract for the entire steam plant, which has been efficiently installed under the personal supervision of their well-known engineering expert, Mr. C. T. Combs. The second room contains the two 125 h. p. compound Westinghouse engines, at 100 pounds steam pressure, having special flywheels of double the ordinary weight, insuring close regulation under the sudden changes incident to heavy loads. Coupled directly to the engines by two of Schieren's perforated electric belts 16 inches in width by 53 feet long are two Westinghouse compound wound generators of the improved U. S. type, each of 100 h. p. capacity, having 54-inch paper pulleys running at 350 revolutions. These generators rest on a brick foundation six feet in depth, and leveled off with a half-inch layer of melted sulphur, on top of which rests a hard wood base eight inches in height, that is covered with three sheets of one-eighth inch asbestos previously saturated with P. & B. paint, and thoroughly dried. On this the rails are placed and firmly fastened to the foundation by insulated bolts. Powell's patent oil cups and lubricators are used on both engines and generators.

The dynamo leads are carried from the generator through rubber tubing down to and under the flooring and to the switchboard—a handsome affair of polished sycamore with marble face—on which is placed the improved form of Westinghouse voltmeter, lightning arrester, automatic cutouts, switches, etc. Independent circuit insures the necessary light in station and car-house at all hours.

The car house is within 100 feet of the station and is a brick building 50 × 150 feet, designed to hold 20 cars, and containing every requisite for the rapid handling of same. The present equipment consists of six new motor cars, eight old trailers and the steam dummies. Each of the new cars is equipped with two McGuire improved trucks, each of which supports a 30 h. p. Westinghouse single reduction motor especially built for the heavy work required on this line.

The motors have been placed in operation under the supervision of Mr. Claud P. D'Oyly, from the Pittsburgh factory.

The nine miles of road-bed is nearly a continuous series of curves, there being 38 in number, ranging from 4 degrees to 20 degrees, and has been built through several deep cuts, from one of which over 60,000 cubic yards of earth were removed, at an expense of $4,800, while close to the power house there is a trestle built 634 feet long, having a rise of 4 per cent. on a 19-degree curve of 300 feet, the upper end of the trestle being 16 feet above grade. These features necessitated careful construction of the pole-line circuit, and it was supervised by Mr. B. J. Jones, the electrical constructing engineer of the Westinghouse Electric and Manufacturing Company, assisted by Mr. D'Oyly of his corps. These gentlemen had complete charge of the entire electrical installation, and the finished work certainly reflects great credit upon their ability. The pole-line circuit is a model one, every pole being truly aligned and, when necessary, properly guyed. The feed wires are Roebling's weather-proof 000, and the trolley wire No. 0, bare copper, suspended by means of a special form of insulator attached to a bracket arm bolted to the pole, both bracket and insulator as well as all other overhead equipment material, lamps, etc, being furnished by the Electrical Merchandise Company, of Chicago, Ill.

Taken as a whole, the system is one of the most perfect in all its details that has been installed anywhere, and can well be pointed to with pride by the president of the company, Mr. Charles W. Hornick, as well as by the Westinghouse officials. After the formal opening Mr. J. L. Barclay and Mr. J. M. Atkinson, of the Westinghouse Company, entertained at the Hotel Garretson a number of the gentlemen interested in the success of the road. Among the number present were President Charles W. Hornick, Mr. A. N. England, secretary of the Electrical Merchandise Company; Mr. N. P. Senat, representing the *Street Railway Gazette*, Chicago; Mr. B. J. Jones, Mr. C. P. Combs, Mr. C. P. D'Oyly and Mr. Fred DeLand, of THE ELECTRICAL WORLD.

Association of Railway Telegraph Superintendents.

The tenth annual meeting of this Association was called to order by President G. T. Williams, at the Grand Hotel, Cincinnati, Wednesday, June 17, at 10:30 A. M. The following members were present:

G. T. Williams, president, Cleveland, O.
P. W. Drew, secretary and treasurer, Chicago.
C. Selden, B. & O. R. R., Baltimore.
A. R. Swift, C., R. I. & P. R. R., Chicago.
C. W. Hammond, Mo. Pac. R R., St. Louis.
M. B. Leonard, C. & O. R. R., Richmond, Va.
C. S. Jones, Ill. Cen. R. R., Chicago, Ill.
C. A. Darlton, R. & D. R. R., Washington, D. C.
G. L. Lang, N. Y. & N. E. R. R., Boston, Mass.
G. M. Dugan, Ill. Cent. R. R., Jackson, Tenn.
T. J. Higgins, C. C. U. & St. L. R. R., Cleveland, O.
S. K. Bullard, M., K. & T. R. R., Sedalia, Mo.
H. C. Sprague, K. C., Ft. S. & M. R. R., Kansas City, Mo.
U. J. Fry, C., M. & St. P. Ry., Milwaukee, Wis.
C. H. Smith, I., I. & I. R. R., Kankakee, Ill.
A. R. Lingafelt, C., R. I. & P. R. R., Topeka, Kan.
Robert Stewart, C. R. R. of N. J., Elizabeth, N. J.
H. C. Reed, M., L. S. & W. R. R., Milwaukee, Wis.
J. B. Stewart, West Shore R. R., Weehawken, N. J.
J. W. Stacey, Tex. & Pac. R. R., Marshall, Tex.
W. C. Walstrum, N. & W. R. R., Roanoke, Va.
T. W. Parks, I. & G. N., Tyler, Tex.
S. S. Bogart, (honorary member), New York.
R. J. M. Danley, C., S. & H. Ry., Columbus, O.
F. M. Duncan, D. & R. G., Denver, Colo.
F. W. Wilson, G. R. & I. R. R., Fort Wayne, Ind.
A. Hayward, O. & M., Cincinnati, O.
K. McKenzie, M. & O., Jackson, Tenn.
E. R. Adams, P. & R. R. R., Reading, Pa.
W. D. Vincent, B. & O. R. R., Pittsburgh, Pa.
W. P. McFarlane, F. E. & M. V., Omaha, Nev.
G. R. Kimball, B. & O., Newark, O.
J. L. Orbison, C., H. & D. R. R., Cincinnati, O.
H. C. Hope, C., St. P., M. & O. R. R., St. Paul, Minn.
Horace Johnson, C., W. & B. R. R., Chillicothe, O.
W. P. Ward, B., C. R. & N., Cedar Rapids, Ia.

Twenty-one new members were elected as follows:

H. J. Adams, B. & M. R. R., Alliance, Neb.
J. H. Jacoby, Lehigh Valley R. R., South Bethlehem, Pa.
W. P. Ward, B., C. R. & N. R. R., Cedar Rapids, Ia.
A. D. Halliday, D. & I. R. R. R., Two Harbors, Minn.
J. P. Boyle, K. & W. R. R., Centreville, Ia.
W. P. McFarlane, F. E. & M. V. R. R., Omaha, Neb.
G. E. Evans, L. & N. R. R., Louisville, Ky.
E. R. Adams, P. & R. R. R., Reading, Pa.
C. G. Scholes, A., T. & S. F. R. R., Chicago, Ill.
K. McKenzie, M. & O. R. R., Jackson, Tenn.
W. D. Vincent, B. & O. R. R., Pittsburgh, Pa.
J. M. Egan, St. L. & S. F. R. R., Springfield, Mo.
R. J. M. Danley, C. S. & H. Ry., Columbus, O.
G. R. Kimball, B. & O. R. R., Newark, O.
E. R. Scoville, B. O. & S. W. R. R., Chillicothe, O.
H. G. Johnston, I., I. & I. R. R., Kankakee, Ill.
W. W. Jackson, N. Y. & N. E. R. R., Providence, R. I.
J. W. Dawson, K. & M. Ry., Charleston, W. Va.
F. Peters, S. P. R. R., New Orleans.

Mr. Chas. S. Jones, Illinois Central Railroad, Chicago, Ill., was elected president and L. H. Korty, Union Pacific Railroad, Omaha, vice-president for the ensuing year. P. W. Drew, of Chicago, was re-elected secretary and treasurer. Invitations to hold the next meeting at Denver, Colo., were presented from J. J. Burns, master of transportation, Denver & Rio Grande Railway; Hon. Platt Rogers, Mayor of Denver, and Hon. John S. Routt, Governor of Colorado.

Mr. A. R. Swift then took the floor and said that for the past two years he had been very desirous that the Association should meet at Denver, and believed that the occasion could be made one of the most profitable and enjoyable in its 10 years' history. He took pleasure in presenting a letter from Mr. St. John, general manager of the Rock Island system, which was a most encouraging recognition of the work of the Association. The letter was read as follows, and it was voted that it be spread upon the minutes:

Chicago, Rock Island & Pacific Railway, General Manager's Office,
CHICAGO, ILL., June 11, 1891.

A. R. Swift, Esq., Supt. of Telegraph C., R. I. & P. Ry.:

DEAR SIR—The Association of Railway Telegraph Superintendents should represent progress. The world to-day is watching for achievements, knowing full well that in the no distant future the element forced to serve you will be called upon to render far greater service than in the past. "Knowledge is power," and your meetings, held for the purpose of obtaining increased knowledge, must prove of benefit to mankind, and of very great benefit to the interests which you directly serve. We believe in your organization and its power for good, and have read its past proceedings and the papers presented by its members, which were able and interesting, and desire to encourage its efforts.

Understanding that your present meeting will determine the location of the annual meeting of June, 1892, I want to suggest Denver, Colo., and to say through you to the president of your organization and its members that should Denver be selected it will afford us much pleasure to extend the courtesy of free transportation to Denver and return to its members and ladies and to further aid in every way consistent to make the journey pleasant and enjoyable to all.

Very truly,
E. ST. JOHN, General Manager.

It was voted unanimously to hold the eleventh meeting of the Association at Denver on June 15, 1892. A telegram was read by the secretary from C. E. Case, Secretary of the Train Dispatchers' Association of America, in session at Toledo, O., extending congratulations and good wishes of the Association. Messrs. A. R. Lingafeld, C. G. Sholes and F. M. Duncan were appointed as a Committee of Arrangements to make preparations for the Denver meeting. Mr. Selden, from the Committee on Topics and Papers, reported that such papers as were ready for presentation would be taken up at the Thursday afternoon session. Upon motion of Mr. J. B. Stewart, it was voted that the annual dues be raised from $3 to $5 after the current year.

THURSDAY'S SESSION.

Mr. S. S. Bogart gave notice that his paper on electric railways would be forwarded to the secretary to be printed in the minutes. A communication was received from a school of telegraphy in Minneapolis inviting the co-operation of the Association.

President C. S. Jones then took the chair.

The following paper was read by Mr. G. L. Lang. It should be said in justice to Mr. Lang and others who prepared papers for this meeting that owing to the disorganization of the committee caused by the retirement of its chairman the members were not called upon to prepare their papers until their arrival at Cincinnati, and consequently they were not as complete as they otherwise would have been.

CARE AND MAINTENANCE OF ELECTRIC BLOCK SIGNALS.

G. L. LANG.

Electric signals for keeping trains a certain distance apart, commonly called "block signals," are slowly but surely coming into use. The very able and exhaustive paper read by Mr. Stewart one year ago has placed before us various systems now in use. Other papers have called attention to the use and value of such signals, but no one has given us even a hint as to what was necessary to make these signals effective after they were once placed upon a railroad.

I find the usual condition to be something like this:

Some smooth-tongued representative of one of the various signal companies will secure an interview with the general manager, usually selecting a time when the recollection of some accident is fresh in his mind, and show to him how by his system such an accident would be impossible.

Cost of appliances and cost of erection are shown to be nothing compared to one first-class "tail-ender."

No argument is necessary to demonstrate the value of such appliances; so the matter settles itself into a question of cost. Ordinarily not a word has been said about the cost of maintenance; so the official gets the idea that to once equip his road with signals the cost stops; that they will run themselves, so to speak, displaying automatically and continuously almost the intelligence of a human being. The signals are ordered, placed in position and are found to work splendidly.

Soon engineers begin to report signals out of order; standing at "danger" improperly. The roadmaster is probably notified, who knows no more about it than a child, except that it is "electric"; so he hunts up the telegraph lineman, who knows but little more. The result soon is that all the signals are at "danger" and the company putting them in is notified that the signals are a failure. Upon investigation the signal company usually finds the whole trouble to be *want of care*.

Thus we see the signals have got a bad reputation through no fault of their own, while the general manager discovers that the first cost is but the beginning of the expense.

What I say may have a strong "chestnut" flavor to most of you, but, knowing how many comparatively simple things I had to learn, or learn to apply, when I commenced the care of signals, I venture to mention a few of the

* Read at the Tenth Annual Meeting of the Association of Railway Telegraph Superintendents, Cincinnati, O., June 18, 1891.

points where trouble is apt to appear. As my experience has been mainly with a battery signal, what I say will more particularly have reference to the systems using a battery.

First of all select an intelligent man to take care of your signals, and impress upon him that eternal vigilance is the price of a perfect-working signal. He should clean his battery zincs very often to keep the internal resistance at the minimum, the external resistance being merely nominal.

A point not very generally understood by batterymen is that a battery that will work a four-ohm sounder for two weeks will only work a signal circuit of half an ohm resistance one week.

When the zinc becomes reduced one-half in size we do not notice it in a circuit of high resistance, but it is fatal to a circuit of very low resistances. In our service we have two circuits of different resistances; one from half of one to two ohms, the other from 10 to 20 ohms. We transfer the half-consumed zincs from the low to the higher resistance circuits, keeping up the efficiency of both batteries. Before leaving the subject of batteries I want to say that fully nine-tenths of the failures recorded on block signals can be legitimately charged to the battery, showing that this is the main point to watch.

Another point that if carefully and intelligently watched will save much anxiety and search for cause of trouble is the relay.

Every relay should be hermetically sealed, so no dust can prevent the points from making sure and perfect connection.

Every relay should be protected by a lightning arrester of some kind, as, strange as it may appear, relays in a circuit made up of the steel rails of the track and underground wires with no line wires whatever are often burned by lightning. Where the track is used as a circuit the joints are usually bridged by wires fastened to the rails by rivets driven into holes drilled for the purpose. Here is something that requires very close watching.

The track workmen are often ignorant, careless, or both, breaking the wires or loosening the wires on the rivets. A detecting galvanometer is a very valuable help in locating faults of this nature.

In systems using the tracks for the circuit, insulations are necessary to divide the track into suitable signal sections, as well as for other purposes. These require great care in first introducing, as well as careful watching from day to day.

The insulating material may be of wood, vulcanized fibre, leatheroid, laminar fibre or other suitable material. The exact manner of introducing these insulations varies on different roads.

The cost per signal for maintenance of double-track block signals is not far from $40 per annum, varying somewhat according to the traffic. Notwithstanding the expense of installing a complete signal system, and expense of care, I believe their use to be an economy when the traffic is as heavy as is the case on some parts of most of our leading railroads.

By the aid of these automatic signals trains are run into and out of the cities safely at intervals of one, two or three minutes, regardless of fog or weather. Without signals this could not be safely accomplished. As I remarked in the beginning, the perfect-working signal displays intelligence little short of human—never sleeps on duty and never gets drunk.

In discussing Mr. Lang's paper, Mr. Robert Stewart said that on the Central Railroad of New Jersey trains were started out from one-quarter to one-half minute apart, some of the blocks being comparatively short.

In reply to an inquiry regarding damage from lightning, Mr. Lang said that during an electrical storm in May seven relays were burned out which were connected with a track circuit, and having not more than 10 feet of line wire. Previous to this storm they had not used lightning arresters for track circuits, but did so now. The form adopted was made of two plates of copper separated by paraffined paper.

Mr. Williams stated that several years ago on the Pan Handle Road, near Dalton, Ill., he saw 18 poles which had been struck and destroyed by lightning, although no wires were on them, it being a new line of poles. On the other side of the track the poles having wires on them were not disturbed.

Mr. M. B. Leonard, of the Chesapeake & Ohio Railroad, read a paper on "The Phonoplex for Railway Telegraph Lines." He said that with the increase of traffic there was a corresponding growth in the use of the railway telegraph, but it was frequently difficult for a superintendent to obtain additional facilities. It had therefore been necessary in many cases to adopt devices used by commercial telegraph companies to increase the carrying capacity of the wires. The phonoplex, besides increasing the capacity of existing lines, possessed several distinct advantages over the Morse apparatus. Its operation was not affected by the weather. In most instances it would work over a break in the wire where parallel wires existed, the induced current jumping over to the companion wire, and thus bridging the break. The phonoplex formed a never-failing means of communication with all offices. The battery now used in connection with it is the Edison-Lalande. On the Chesapeake & Ohio line during the December blizzard all the wires were down between Clinton Forge and Richmond. The phonoplex worked steadily until the other wires were cleared up. The Kansas City & Fort Scott Railway had had a similar experience. He believed that in the Chesapeake & Ohio service the system had paid for itself several times over.

In response to an inquiry as to the nature of the damage to the line referred to, Mr. Leonard said that the wire was broken, crossed and grounded. They worked through the break by the induced current, but could not say which wire it was on. There were four stations between Clinton Forge and Richmond. The operation of the phonoplex could only be stopped by an absolute break where there was no other wire for the current to pass over.

Mr. Robert Stewart inquired if it would work through a leaky wire in a seven-conductor cable a mile in length; if so it would be valuable, as cables were expensive. No positive reply was elicited to this inquiry, and it was thought it could only be determined by actual experiment.

Mr. Lang stated that it could not be worked on two wires strung on the same set of poles.

Mr. Selden stated that the Baltimore & Ohio company has a wire 120 miles long, with 30 stations, which they wished to have equipped with the phonoplex, but after several months' experimenting the attempt was abandoned as impracticable. He confirmed Mr. Leonard's statement that it would work over a break under the conditions stated. The Baltimore & Ohio Railroad has a set working between Philadelphia and Baltimore, and several sets in New York City. Their longest circuit was 91 miles, but circuits 300 miles long were worked on other roads.

Mr. Lang stated that between Hartford and Boston the phonoplex worked admirably up to within 40 rods of the Boston office, where the wire entered a cable 75 feet in length, which contained a Western Union ticker wire. That made it practically useless.

Mr. U. J. Fry, of the Chicago, Milwaukee & St. Paul Railway, read a paper on the "Quadruplex."

After a brief explanation of the apparatus he referred to various applications which could be made besides its use between two stations. In their service they quadruplexed one wire between Chicago and Marion, Ia., 225 miles, and work a single wire from Marion to Omaha, 30 miles into one side, and another from Marion to Kansas City, 306 miles into the other side. This enables the Chicago office to work with any or all offices from Marion to Omaha inclusive. Another wire between Chicago and Milwaukee is quadruplexed. They work a single wire from Milwaukee to Minneapolis, 345 miles on one side and on the other side is worked a single wire from Milwaukee to Prairie du Chien to Canton, S. Dak., 30 miles during the night, and in the daytime this circuit is disconnected and that side of the quadruplex is worked duplex. With this arrangement at Milwaukee, they are enabled to close the night offices, allowing the wires to work through, giving the general office at Chicago access to the entire system through other night offices. With the aid of these combinations and automatic repeaters at junction points they can during the daytime place their general manager's office in direct communication with any division superintendent's office on the system at very short notice. They run two wires from the telegraph office to the general manager's office---one to a key and sounder for transmitting, the other to a sounder for receiving, thence to ground, and with the aid of four switches they can extend the local circuits of either quad set down to his office on these two wires. The repeating sounder on No. 2 side is frequently examined in search of trouble. They have now dispensed entirely with this sounder, by placing the reading local circuit in place of the repeating local circuit on the neutral relay, and allow that relay to close the local on the back stop as before; then exchange the tap wire and long end, which places the short end of battery to line with key closed. Give signal on back stroke at distant end, and the whole battery to line with key open, breaking local at distant end. This change is found very beneficial in working single into quadruplex circuits where it is necessary to keep keys closed, in that, that when circuits are idle the short end is to line, preventing the heating of rheostat which otherwise would occur, and require continual watching. This he believed to be the proper and most economical way of operating a quad, because overcoming the danger of operators who worked on both quad and single wires from leaving single wire keys open. This change necessitated closing the key on quadruplex wires as well as single wires, rendering the use of keys uniform. Mr. Fry also submitted a plan by which they expect to operate several quadruplex sets from one battery.

In the course of the discussion of Mr. Fry's paper, Mr. C. Selden availed himself of the opportunity to state that he felt a deep personal interest in the subject, as he believed he stood beside the bedside when the quadruplex was born. In 1869 he was located in Cincinnati, and in company with Mr. E. T. Gilliland was engaged in experimental electrical work. One day an old gentleman came in and wanted to know if he could get a Varley polarized relay. I told him we had none in stock, but could get him one. He wanted to know how long it would take and what it would cost. I said we could get it in a few days, but could not give him the price at that time. He stated that he was a poor farmer up at Mount Washington, and that I was the first person he had found who knew what a polarized relay was. After he had gone Ned said (we always called him Ned, but his name is Ezra): "What did the old fellow want?"

"A polarized relay."

"What is that?"

"I don't know, but I am going to find out."

I went up to the library and found they had a set of De la Rive, but it was so highly valued that I could not borrow it. I looked it over and found a description of Varley's polarized relay, and the minute I found it I wondered why we didn't know something of it before. Next day we were ready to make it. Our customer's name was Dr. Nicholson. He proposed to have a Varley relay that would respond to a positive, and another that would respond to a negative current, and a neutral relay which would respond to a stronger current and control both sounders. He constructed an alphabet also. He had figured it out that a dash took as long to make as a "p." By his system, for instance, a tick on one sounder and a flap on the other would mean "b." It was put in operation between Cincinnati and Maysville, Ky., and business was transmitted by it. Dr. Nicholson was a very ingenious man. In 1858 he ran a skiff across the Ohio River with an electric motor. He took his telegraph apparatus to New York, and was told that it would not work; that the positive and negative plan was all right, but that the stronger current he proposed would not answer the purpose. At that time a duplex was working between Cincinnati and Louisville, and frequently the business was all piled up at one end. We thought that by using the Doctor's device the capacity of the wire could be doubled in either direction. It never occurred to me that if we could do this, we could, by introducing a differential relay, produce a quadruplex. I said to the Doctor, "Have you got any money?" He said that he was pretty well cleaned out up at the farm, and had nothing left but a cow. I told him to go and sell his cow, for I believed he had got 4 for 1. The Doctor went to Washington after his patent, and made a contract with the Western Union, and his device was tried between Chicago and Cincinnati, but it was not a success. Shortly after that the quadruplex was brought out through the efforts of Edison and Prescott, and with the resources of the Western Union company. I do not think the Doctor would have accomplished this result, as he was imbued with the idea of shortening the alphabet. His claim was subsequently recognized by the Western Union company, and he received a suitable compensation for his invention.

Resolutions of thanks were passed to the various companies and individuals who had aided in making the meeting a very pleasant one. None were more heartily indorsed than that which acknowledged the courtesy of the Cincinnati Electric Light Company in providing an electric motor fan for the meeting-room, which made it one of the most comfortable spots in the city.

At 5:30 P. M. the meeting adjourned.

EXHIBITS.

Thursday, at 10 A. M., the Association visited and inspected officially the various exhibits of electrical apparatus.

The Hall Signal Company exhibited a working sample of the Stewart-Hall train order signal, which was very favorably commented upon. This signal is the invention of Mr. Robert Stewart, Superintendent of Telegraph of the C. R. R. of N. J., and has been fully described in our columns.

The necessity of an individual call has long been appreciated by all who are engaged in railway telegraphy and this want has now been provided for. Two working systems were shown, embodying similar principles, one by the Gill-Alexander Electric Manufacturing Company, of Kansas City, Mo., represented by Mr. Gill, and the other that of the Electric Secret Service Company, of New York City, represented by Mr. S. S. Bogart and Mr. Mackie. The latter system differs from the Gill-Alexander in the use of an automatic transmitter; the insertion of one of any number of special plugs enables the calling office to secure the attention of any desired distant station by the ringing of a vibrating bell. In the Gill system the regular Morse key is used for sending the required combination, which is an exceedingly simple operation.

The Union Switch and Signal Company exhibited a revolving signal showing danger and safety by signals like semaphores, which are now generally recognized as being the most satisfactory.

The Edison phonoplex system was shown in actual operation over a Chesapeake & Ohio wire. In conjunction with it, various types of the Edison-Lalande battery were shown, also condensers manufactured by Wm. Marshall.

A working sample of O'Neil's automatic highway crossing alarm was shown by A. L. Dunbar, general agent; also a signal for the same purpose invented by E. M. Chase.

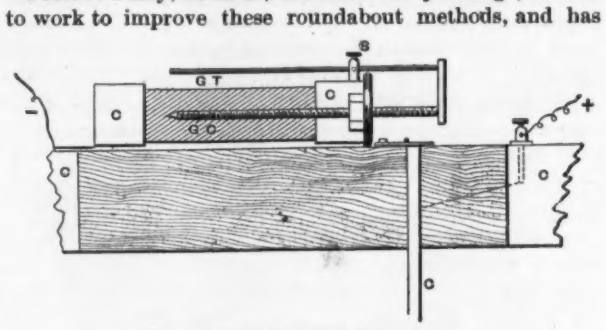
I. N. Miller, of Cincinnati, showed a sample of his protector for telephone and telegraph instruments against lightning and heavy currents, and W. P. Ward a working set of a very simple repeater.

Dennison's Automatic Telegraph was the most interesting exhibit at the meeting. It reproduced in fac-simile drawings, autographs, etc., in a very perfect manner, transmitting and receiving being effected by rapidly vibrating arms across the metallic tape at one end and the chemically prepared paper at the other. A similar but more perfect reproduction was obtained by use of an embossed slip.

Another Early Granular Carbon Rheostat.*

BY A. M. TANNER.

My published researches concerning the variable resistance of carbon under pressure show that in 1835 Munck, of Rosenschöld, experimented with differently compressed carbon powder for varying the force of an electrical discharge, and that in 1861 Beetz placed spongy platinum in a glass tube and compressed it more or less by means of a piston in order to change its conductivity. Hence it appears that neither Du Moncel, Clerac nor Edison first discovered the principle in question, as some of the electrical text books have it. Another reference is to be added to the list of rheostats or electric-current regulators making use of granular or powdered carbon—it is the French patent of Emanuel Rebold, dated March 2, 1857, No. 32,415, which shows what is termed a current moderator for induction coils. The sketch here given is taken from the drawing of the patent, and shows a glass tube having copper caps and filled with granular carbon. A screw stem penetrates into the carbon and can be adjusted by a milled nut. After adjustment the rod is held stationary by a guide stem and set screw. The strength of the current is varied by causing the screw rod to penetrate more or less into the granular carbon. It will be seen that Rebold did not propose to obtain a change of conductivity by an endwise pressure upon the carbon mass, but obviously the movement of the screw rod will produce a slight compression in the direction of the walls of the glass tube, and thus the degree of penetration of the rod and the lateral compression of the carbon granules will bring about the desired result, just as is the case in that class of microphones where solid projections on the diaphragm co-operate with granular carbon.



GRANULAR CARBON RHEOSTAT.

C—copper; *G C*—granulated carbon; *G T*—glass tube; *S*—set screw.

The "Perry" Engine Indicator.

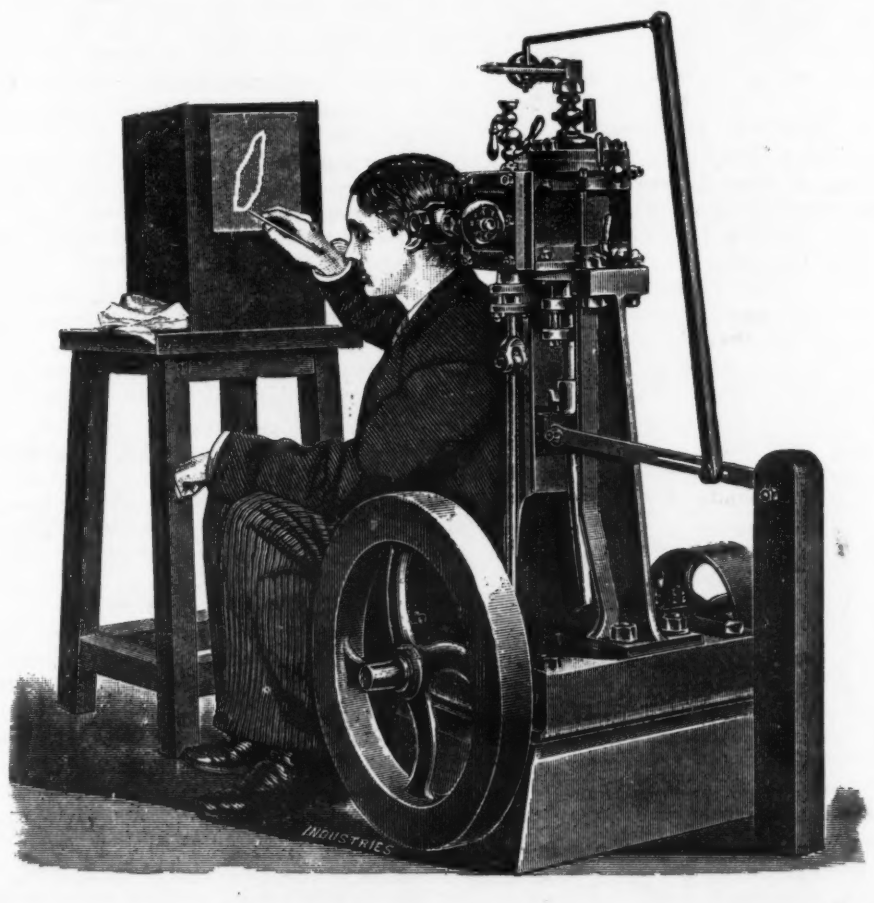
To some engineers the accuracy of the ordinary engine indicator is a sort of faith; others are, however, a little skeptical. In 1885, says *Industries* (London), Prof. Osborne Reynolds read a paper at the Institution of Civil Engineers which did much to disturb our confidence in the general accuracy of indicator diagrams. In it attention was called to several serious sources of error, such as inertia of the moving parts, friction of the piston and the pencil gear, backlash and "give" in the pencil gear, temperature variations in the springs, inaccuracy in the springs, long and tortuous steam connections, stretching of the string, and want of correspondence between the motion of the paper and of the engine piston. These disturbing elements give rise to very large errors, and, even if we do not estimate them so high as Prof. Reynolds, it must be admitted that the steam-engine indicator with the usual arrangements for giving motion to the barrel is not an extremely accurate instrument, even in its most improved form.

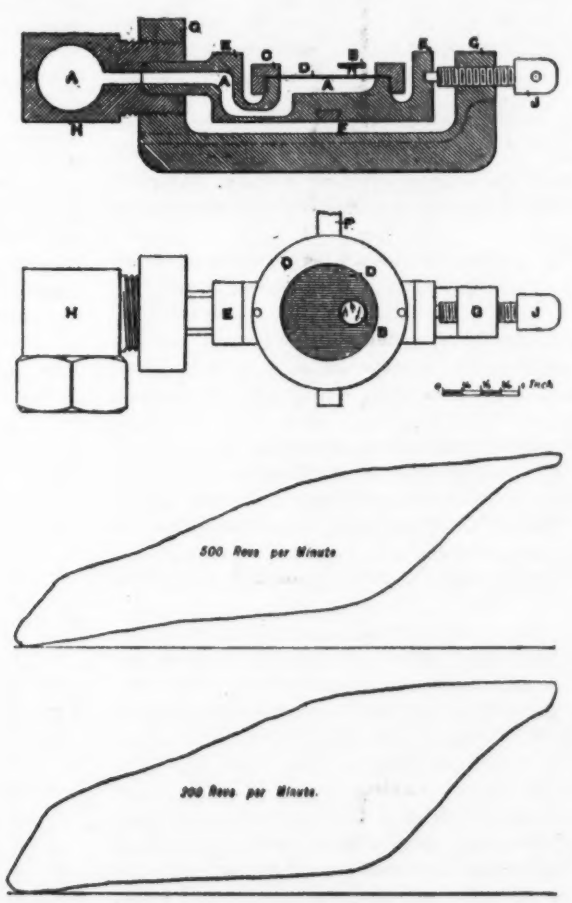
Apart from these features of inaccuracy the engine indicator is, after all, a roundabout sort of instrument to get a desired result. If an engineer wants to know the pressure in a boiler he looks at a direct reading gauge; but if he wants to know the power developed in an engine he fixes on an indicator, but this does not show the power at once. The engineer has probably to climb about to fix his indicator on the engine cylinder. If the engine be in a ship, and there is a big sea on, the experimenter in taking a diagram may tear several cards and probably burn his fingers, and in some cases run a chance of being killed. After all this he has not got the horse power result, but merely a diagram. Additional observation of the speed must be taken, and the area of the diagram must be measured with a planimeter or other means. After doing all this, a result having some sort of relation with the power in one end of one cylinder is obtained, and several more operations, with their accompaniments, give the final results.

Prof. J. Perry, F. R. S., of the Finsbury College, has set to work to improve these roundabout methods, and has produced the very simple and ingenious form of indicator which we illustrate in Figs. 1, 2 and 3. The piston and cylinder are discarded altogether. Instead of them there is a thin steel drumhead *D*. The pressure in the box *A* bulges the disc out a little like the disc of an aneroid barometer or Schäffer-Budenberg gauge. A mirror *B* is set about half way between the centre and the edge. The pressure thus bends the disc and deflects a beam of light in one direction. The drum is moved in another angular direction by means of a lever *F*, and this moves the spot at right angles to the pressure direction. The result is that the spot traces a true diagram of the working of the engine. The steel disc is so light and strong that its period of vibration is too high for its inertia to affect the diagram, not only of a marine or mill engine, but even to make a perceptible difference on a locomotive, a small gas engine, or a high-speed electric light engine. The barrel cord is entirely superseded by a rigid rod or connection which does not admit of stretching or backlash.

The diagram formed by the instrument may be made permanent, as it can be traced over with a pencil. An oil lamp, with a large mirror, gives a good "spot," and even at the slow speed of 60 revolutions it is easy to trace the form of the diagram. For many purposes, however, a record is not wanted. With the "Perry" indicator the engineer may not only have the water, boiler pressure, vacuum and other gauges in front of him, but he may have a visible indicator diagram also. He has not to perform a series of operations whenever he wants to know what is going on inside of the cylinders of his engine, and he can watch the effects of any alteration of boiler pressure or of the valve gear without difficulty or trouble.

Prof. Perry read a paper on his indicator before the Physical Society on May 22 and showed a number of diagrams taken by Mr. Holland, who has been engaged in working out some of the details. Fig. 1 shows a general view of the indicator as attached to a small engine, Fig. 2 is a longitudinal section and Fig. 3 a plan of the instrument. Figs. 4 and 5 are specimen diagrams taken with it, which were photographed by the light of an oil lamp, after about a minute's exposure.





FIGS. 1-5.—GENERAL VIEW, DETAILS AND SPECIMEN CARDS OF PERRY'S ENGINE INDICATOR.

* From the *Electrical Review* (London).

The Use of Slate for Electrical Purposes.

BY T. J. MURPHY.

If the electrical industry has found new uses for mica, porcelain, lava and other known insulators, it has certainly done wonders for the producers of slate. Formerly this article had its greatest sale for mantels, lamp bases and washtubs, to say nothing of the ordinary school slates; but recent experiments show that a species of slate quarried in Vermont is among the best known insulators where a large area is to be covered, such as switchboards and the like; it is even displacing the use of hard rubber and fibre for many smaller articles, on account of the various styles of finish which can be given to the slate, such as imitation of all the different kinds of wood, blood-stone, Tennessee marble, hard rubber—either dull or polished—the slate retaining its moisture resisting and fireproof properties, for which it is superior to any other material now in use.

Slate one inch thick weighs about 14 pounds per square foot, and when it is of the select quality is easily drilled and tapped so that machine screws can be used. Recently a New York construction company drilled 12,000 one-fourth inch holes in a piece of slate containing only 22 square feet, ⅝ of an inch thick. It withstood shop handling and transportation, and considering that the holes were only one-fourth of an inch apart it speaks well for the strength of the slate.

The best slate for electrical purposes, as stated, is found in Vermont, where, probably owing to the absence of iron ore and other metals, the slate is much purer than that quarried elsewhere. Soft slate has a slightly greenish color, although it is frequently found in "purple stock" and other colors.

It is found that "marbleizing" slate adds to the moisture resisting qualities of it, besides giving it an artistic effect, which is greatly increased when moldings are used in connection with it. It has also been found that Pennsylvania slate, besides containing iron, is harder to drill, and there is consequently a more rapid wearing away of the edge of the drill, and careful tests have demonstrated that the selected Vermont slate is the best for electrical purposes. The Manhattan Building, on Wall street, New York City, is equipped with a fine slate switchboard, built by the Eureka Electric Company, which has also furnished one to the Gerlach Apartment House on West 27th street. The American Bell Telephone Building, in Boston, has recently added a slate switchboard, built by the Western Electric Company, and the Manhattan Electric Company, New York City, has placed in position an incandescent switchboard in the station at 30th street and Avenue B, the board being built by V. Prentis, 303 Kent avenue, Brooklyn. This gentleman formerly used Pennsylvania slate, but found it so expensive, on account of the cost of drilling, that he concluded to make a change. He secured some Vermont slate and found that he could drill it in about one-half the time, and it was also found to test up better.

Where switchboards are made in sections it is well to make a drawing or give the exact dimensions, and indicate where screw holes are to be, so that the switchboard can be drilled before marbleizing, although it can be drilled afterward if care is taken to start the drill on the marbleized side, for if drilled in from the back the finish is liable to be cracked off very much like a veneer.

After slate has been quarried and sawed into marketable thickness, which is generally about one inch, it is "flowed,"

i. e., a composition paint is poured over the surface. It is then put in a kiln or heating oven and kept for several hours at a temperature of about 150 degrees. If it is to be of a higher finish a second coat is given to it, and it is again baked the same as before. It is then rubbed with fine pumice stone until a smooth surface is had, after which a coat of fine varnish is applied and it is baked once more. In fact, the finishing of it is very much similar to the finish given piano cases, only, of course, not so highly polished. The slate can be beveled or any of the ordinary forms of moldings can be given to the edge. Frequently a separate molding of a different finish is placed around the board to frame it.

Factory Lighting.

The great increase of output and improved products of the modern factory over the old-fashioned "shoppes," such as Franklin must have seen, is not entirely due to advance in the line of machinery and skill, but to the improvement in facilities and comfort by the modern manner of lighting and ventilating. For years, danger has always been at hand in flour mills from the combustible dust present in the air, but now all this has been remedied by the introduction of incandescent electric lighting.

The advantages of electric lighting in factories are admirably and statistically illustrated in the report of the chief inspector of factories in England for last year, in which the following appears:

"The introduction of the electric light into factories will conduce very much to the healthiness of some occupations and the comfort of all. Mr. Beaumont, H. M. inspector for Bradford, has procured the following comparison of the temperature in a wool-combing shed when lighted by electricity and by gaslight during 24 hours:

Time.	Electricity.	Gas.	Time.	Electricity.	Gas.
	Degrees.	Degrees.		Degrees.	Degrees.
7 P. M. ..	93	95	2 A. M.....	95	108
8 "	94	101	3 "	95	107
9 "	94	104	4 "	95	107
10 "	95	106	5 "	95	107
11 "	96	108	6 "	95	107
12 "	96	109			
1 A. M....	96	108	Average..	95 degrees	105.1 deg.

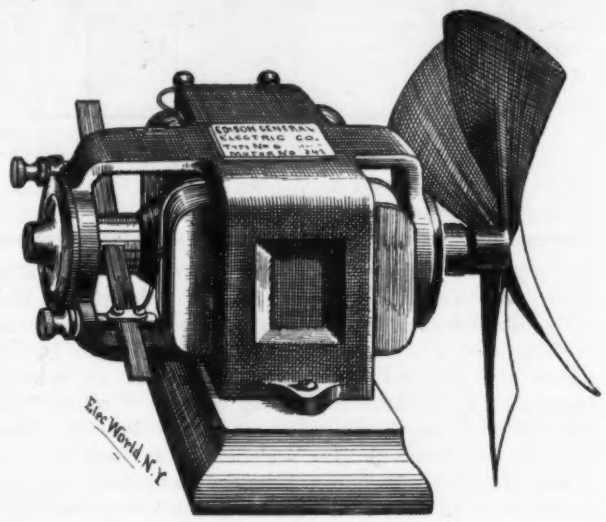
Wool-combing requires that the machine should be heated, and as the operations continue frequently night and day, it will be readily conceived what the condition of the atmosphere must be when heated by the machinery and the gas.

A Simple Voltaic Battery.

A novel and simple form of electric battery has recently been invented in Italy and is described in the London *Electrical Engineer*. It consists of conical vessels of cast iron and porous earthenware, with nitric and sulphuric acid. An iron cone is placed point downwards in a stand, and is partly filled with strong nitric acid. Into this there is placed a cone of porous earthenware containing dilute sulphuric acid. Then follows an iron cone, surmounted by an earthenware one, and so on in a series, each vessel containing its respective acid. It follows that the inner surface of each iron vessel is bathed in nitric acid, and becomes passive, acting the part of the platinum or carbon in an ordinary cell. The outer surface is attacked by the dilute sulphuric acid, and takes the place of the zinc. There are no connections to make, the simple building of the pile putting all the parts into union. The earthenware cones are eight inches in diameter and four inches in height, and contain 550 cubic centimetres of 10 per cent. sulphuric acid solution. The iron vessel contains 110 cubic centimetres of nitric and sulphuric acids, the latter being three times the volume of the former. Sixty elements, arranged in two piles, have a resistance of 10¼ ohms, an E. M. F. on open circuit of 81 volts, and on closed circuit of 45 volts, with a current of four and four-tenths ampères. After five hours the difference of potential falls to 28 volts, and the current to two and seven-tenths ampères.

A New Fan Motor.

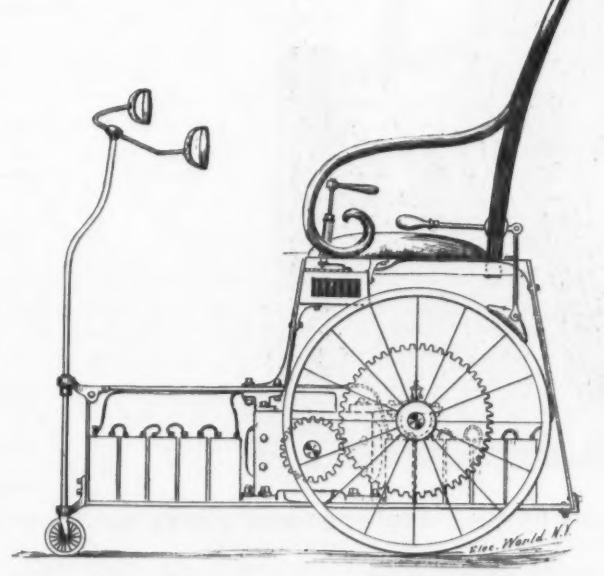
The accompanying illustration shows a little fan motor recently brought out by the Edison company that possesses some features of peculiar interest. The motor is manufactured for the Edison company by Mr. Chas. A. Lieb, some of whose work has been noticed in THE ELECTRICAL WORLD from time to time. It is intended almost exclusively for fan work and is consequently a low-power motor wound for the regular Edison circuits. The field magnet is of the iron clad type with a pair of salient poles magnetized by coils wound on bobbins and slipped over the poles before the armature is put in. The bearings of the armature are supported by a pair of brackets that form part of the same castings as the field magnets. As will be seen from the illustrations they are of small section, and instead of coming down to the usual shape of bearing are formed into a pair of rings having a diameter a little larger than that of the armature. A pair of brass bearing plugs fitted into these rings support and centre the armature. The construction is thus of extreme simplicity. A single boring at once smooths out the bearing rings and the field, so that the armature can be slipped into position and the bearing put on over it. The commutator is constructed and connected in the simplest manner, and the two brush holders are connected directly to the main castings of the motor. The armature is a simple drum made up as usual, and the novel features of the motor are really those which bear upon its manufacture. This has been reduced, as may be seen from the description and cut, to the simplest possible terms; it is hard to conceive of a machine of similar character being made with so small an amount of labor and so few parts. It is a beautifully ingenious little motor, and although it has not been generally familiar upon the market, yet some specimens may be seen by those who are interested enough to investigate it, one of these being in the show window of the Wing Disc Fan Company, on Liberty street, where it is one of the smallest members of a very large family of motor fans of various descriptions.



A NEW FAN MOTOR.

The Johnston Electric Invalid Chair.

During the long career of THE ELECTRICAL WORLD there have been described in its columns almost every kind of electrically propelled vehicle—cars, cabs, boats, land and marine bicycles, etc. Mr. Alexander Johnston, of Washington, D. C., has, however, found a new application for the electric motor—the invalid chair—and we believe that such a device as the vehicle described below would meet with a warm reception if successful.



THE JOHNSTON ELECTRIC INVALID CHAIR.

As can be seen from the accompanying sketch, the chair is mounted upon a case which contains the motor and storage cells. The guiding apparatus is like that of an ordinary low-seated bicycle, and at one side of the seat is a lever connected with a resistance box for controlling the motor. At the other side of the chair is the brake handle, which is an ordinary lever friction brake. The motor is wound for a low E. M. F., and is of the slow speed design, connected to the driving shaft by single reduction gearing.

Mr. Johnston gives the following details of this chair: "Five and one-half ampère hours to each pound of weight. Speed, eight miles an hour for five hours, though at lower speed battery will last for 50 miles of travel. Total weight, 150 pounds."

The whole design appears to be one of great compactness and efficiency, and the vehicle is not quite as cumbersome as might be expected. Perhaps we shall see electrically propelled invalid chairs in great force at the Columbian Exposition of 1893.

Electricity Developed by Water Power.

Electricity, as an economical agent for lighting and for power, is no longer in the experimental stage in this country. The great question now agitating electricians, as well as those who have occasion to use electricity in the arts, especially in manufacturing, is, How shall it be produced in the cheapest possible manner?

It is conceded that where water power is already abundant and cheap, and within available distance of the market in which the power is to be used, that the question of economy in the production of electric current is satisfactorily solved. If our large cities were situated near extensive water powers, so that the electric currents generated by those powers could be used in the cities extensively for lighting and power purposes, a vast amount of electrical work would be done in excess of what is now economically available where steam power is used to generate the current. Unfortunately, for the most part, the large available water powers are situated so far from centres of trade and population that electric currents cannot be economically transmitted from the water powers, and therefore we have the unfortunate condition, a large demand and cheap supply, but not near enough together to be united for business purposes.

An exception to this rule does exist in the city of Concord, the capital of New Hampshire. There, on the Merrimack River, is a large power just about being developed, which will not only afford means for a large increase of manufacturing right at the dam, but also supply electricity for all purposes to which this force is or may hereafter be applied in and about the city of Concord. Manufacturing industries now run by steam will unquestionably in a short time be run by electricity. New industries will be started right in the settled portion of the city, which is located four miles from the dam.

The property referred to is owned by the Concord Land and Water Power Company. The dam when completed will furnish a head and fall of 22 feet, and create a reservoir extending up the river 13 miles. Above, among the mountains and hills of New Hampshire, are situated many lakes, among them Lake Winnipiseogee, which, provided with dams, stores the surplus water in flood seasons to be let down during the dry seasons, thus furnishing steady power to manufacturing property along the stream, which includes Manchester, Lowell and Lawrence, already famous as manufacturing cities.

The company has a large tract of land in the city of Concord, lying on both sides of the river, adjacent to the mill sites, beautifully situated in every way, with perfect sanitary conditions, and all within the corporate limits of the city.

New industries are invited by this company, and among them, in particular, invitations are extended to manufacturers of electrical apparatus. There is an abundant supply of cheap labor, one of the most essential conditions to successful manufacturing. The company offers special inducements with reference to both power and land to new corporations locating there, and it is the policy of the city to exempt from taxation such enterprises for a term of years. The laws of New Hampshire are favorable to manufacturers. It is, withal, one of the leading manufacturing States in the Union. This power, when developed, will undoubtedly be quickly taken for electric and manufacturing purposes.

Moonlight Tables for July, 1891.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of July, under his modified form of moon schedule.

TABLE NO. 1.
Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	8:00 P.M.	2	3:35 A.M.
2	8:00	3	3:35
3	8:00	4	3:35
4	8:00	5	3:35
5	8:00	6	3:40
6	8:00	7	3:40
7	8:00	8	3:40
8	8:00	9	3:40
9	8:00	10	3:40
10	9:35	11	3:40
11	9:55	12	3:40
12	10:15	13	3:40
13	10:40	14	3:45
14	11:00	15	3:45
15	11:30	16	3:45
16	12:00 M.	17	3:45
17			
18	12:35 A.M.	18	3:45
19	1:20	19	3:45
20	No light.	20	No light.
21	No light.	21	No light.
22	No light.	22	No light.
23	7:50 P.M.	23	10:20 P.M.
24	7:50	24	10:50
25	7:50	25	11:20
26	7:50	26	11:45
27	7:50	28	12:15 A.M.
28	7:50	29	12:45
29	7:45	30	1:15
30	7:45	31	1:55
31	7:45	1	2:40

Total hours lighting, 150.10.

TABLE NO. 2.
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	8:00 P.M.	2	3:35 A.M.
2	8:00	3	3:35
3	8:00	4	3:35
4	8:00	5	3:35
5	8:00	6	3:40
6	8:00	7	3:40
7	8:00	8	3:40
8	8:00	9	3:40
9	8:00	10	3:40
10	8:00	11	3:40
11	8:00	12	3:40
12	8:00	13	3:40
13	8:00	14	3:45
14	8:00	15	3:45
15	8:00	16	3:45
16	8:00	17	3:45
17	7:55	17	12:00 M.
18	7:55	18	12:00
19	7:55	19	12:00
20	7:55	20	12:00
21	7:55	21	12:00
22	7:55	22	12:00
23	7:50	23	12:00
24	7:50	24	12:00
25	7:50	25	12:00
26	7:50	26	12:00
27	7:50	28	12:15 A
28	7:50	29	12:45
29	7:45	30	1:15
30	7:45	31	1:55
31	7:45	1	2:40

Total hours lighting, 191.45.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, June 20, 1891, in New York, Boston and Washington, were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	80	....
American Telegraph & Cable	100	14,000,000	79	81
Central and South American	100	5,000,000	130	140
Mexican	100	2,000,000	200	215
Commercial Cable Co	100	7,716,000	....	....
Postal Telegraph Cable	100	5,000,000	28	32
Edison General Electric Co	100	9,503,500	100	102
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,929,400	....	....
Edison Electric Illuminating Co.	100	2,567,800	76	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	43	44
" " preferred	25	4,000,000	25⅝	25¾
" " Series C	10	400,000		9¼
" " Series D	10	120,000	7	7¼
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1,000,000	....	....
" European Welding Co	100	1,000,000	....	60
Ft. Wayne Electric Co	25	4,000,000	12	12¼
Westinghouse Electric Co	50	5,000,000	12¾	13¼
Telephone:				
American Bell	100	12,500,000	201	202
Erie	100	4,800,000	48	....
New England	100	10,304,600	50	53
Mexican	10	1,280,000	1.27½	1.30
Tropical American	10	400,000	....	95c.
Edison Phonograph Doll	10	1,000,000	....	75c.
WASHINGTON.				
Pennsylvania Telephone	50	750,000	24	....
Chesapeake & Potomac	100	2,650,000	62	65
American Graphophone	10	600,000	5¾	7
United States Electric Light (Washington)	100	300,000	155	160
Eckington and Soldiers' Home Electric Ry	50	352,000	49½	....
Georgetown and Tennallytown	50	200,000	57	65

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$230@$240	Cumberland	$60@ $62
Central Union	54@ 55	Wisconsin	118@ 120
Michigan	84@ 85	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell.	40@ 43		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$160@$101	Chicago Edison Co.	$145@$150

AFFAIRS OF THE COMPANIES.

The Barr Electric Manufacturing Company, of New York City, states in its annual report that the capital stock is $50,000, all of which has been issued for patent right, and that the indebtedness of the company does not exceed $3,000.

The Frankford Avenue Electric Light Company, of Philadelphia, Pa., last week elected William McIntyre president and John Wilkinson secretary for the coming year, and an entire new board of directors, with the exception of Messrs. Greenwald and Richards.

The Franklin Electric Works, of Peabody, Mass., which succeeded the Robinson-Foster plant, and which manufactured the motors used on the Essex electric road, will be removed to Bridgeport, Conn., about the first of July and be incorporated with the Direct Electric Company of that city.

The Milford (N. H.) Electric Light and Power Company has passed into the hands of Mr. C. S. Caswell, of Lynn, Mass., who has been in the city for the past week looking the plant over and making arrangements for future operations. He contemplates putting in steam power at an early day. This will no doubt enable him to extend the line to Wilton and other points.

The Laclede Company.—The suit of the State of Missouri by Ashley Clover, prosecuting attorney, to prevent the Laclede Gaslight Company from absorbing the Municipal Electric Light Company, has been dismissed in Judge Withrow's court. Attorney Clover stated that the stockholders of the Municipal Electric Light Company, at a meeting of the company held recently, rejected the proposition of the Laclede Gaslight Company to purchase the stock, and the object of the suit had therefore been attained without further legal proceedings.

NEW INCORPORATIONS.

The Portland (Mich.) Electric Light Company has filed articles of incorporation. The capital stock is $10,000.

The Hastings (Mich.) Electric Light and Power Company has been incorporated with a capital stock of $15,000.

The Portland (Mich.) Electric Light and Power Company has been incorporated with a capital stock of $10,000.

The Standard Electric Company, of Minneapolis, Minn., with a capital stock of $10,000, was incorporated last week by Geo. G. Smith, W. J. Reno and J. M. Lennon.

The Edison Illuminating Company, of Wardner, Idaho, has been formed. Charles Sweeny, Alex. Monk, P. C. Conroy, Alfred Page and William T. McCaskey are the interested parties.

The Vallejo (Cal.) Electric Light and Power Company has been incorporated with a capital stock of $50,000. The directors are Samuel Brown, John Maguire, T. A. Thornton, Wm. Walker and J. A. Browne.

The Sun Arc Lamp Company, of Chicago, Ill., has been incorporated to manufacture electrical lamps and supplies. The capital stock is $300,000. The incorporators are: M. L. Coffeen, G. R. Mitchell, C. H. Wells.

The Pontiac Light, Power and Fuel Company has been incorporated at Pontiac, Ill., with a capital stock of $16,000, to furnish light, heat and power. The incorporators are R. D. Lucas, H. D. Spencer, C. L. Caper, H. A. Foster.

The Minneapolis (Minn.) Electric Light and Power Company, with a capital stock of $750,000, has been incorporated. The incorporators are Charles H. Prior, James W. Griffin, Wm. D. Hale, Edward S. Corser, Moses H. Hayes and Alexander Robertson.

The Arapalwe Electric Company, with a capital stock of $500,000, has been incorporated at Denver, Col. The incorporators are E. W. Lowry, W. F. Henderson and J. C. Regan, of Denver; E. J. Riley, of Omaha; C. S. Penfield and J. D. McDonald, of Fremont, Neb.

The New England Electric Brush Company, capital stock $500,000, $500 paid in, has been organized at Portland, Me., for the purpose of manufacturing electric brushes. The officers are: President, Elliot King, of Portland, Me.; treasurer, Joseph Cook, of Lynn, Mass

The Gaston Electrical Manufacturing Company, of Sparta, Ill., has been incorporated to manufacture, sell and apply all kinds of electrical and other machinery. The capital stock is $125,000. The incorporators are J. E. Gaston, D. P. Barker and R. H. Rosborough.

The Idaho Telegraph and Telephone Company has been incorporated to construct and operate lines for telegraphy and telephony in Kootenai county, between the town of Rathdrum, Idaho, and the settlement of Mica, being on the west shore of Cœur d'Alene Lake, via Post Falls, a distance of 15 miles. The principal place of business is Post Falls, Idaho. The company is to exist 50 years, with nine directors, and a capital stock of $10,000.

The Greenwich (N. Y.) Electric Light and Power Company has been incorporated to manufacture and use electricity for producing light, heat or power, and in lighting streets, avenues, public parks and places, and public and private buildings in Greenwich and Easton, Washington county. The capital is $15,000, divided into 150 shares. The trustees for the first year are Henry Gray, LeRoy Thompson, John Brooks, James O. LaVake, of Greenwich, and George A. Packer, of Troy.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, June 22, 1891.

Messrs. J. S. White & Co., electric railway engineers and contractors, late of 50 Broadway, have removed to 29 Broadway, New York City.

Smoking Concert at the Electric Club.—On Thursday evening of last week a large company of jolly smokers and their friends gathered at the club's headquarters, 17 East Twenty-second street, in this city. The occasion was the last entertainment of the season, and this had been arranged in the shape of a concert, nearly all the participants being members of the club. Among the attractions of the programme may be mentioned a piano solo by Mr. Geo. M. Phelps; a vocal solo by Mr. C. McL. Paine; a violin and piano selection by Mr. R. Varley and Mr. Joseph Wetzler; a musical recitation, "On the Banks of the Rappahannock," by Mr. M. J. Sullivan; a piano solo by Mr. G. H. Guy, its composer; two entertaining selections, instrumental and vocal, by Dr. Waldo and his son, and a song by Mr. R. F. Outcault. This last was a parody on the well-known lines, "In other respects we are doing quite well," and consisted of a number of amusing skits on electrical topics and oddities of the day. The verses were composed for the occasion by Mr. J. M. Barr. A phonograph recital was given by Messrs. M. J. and M. C. Sullivan, in which a number of well-known solos and pieces of concerted music were introduced. The affair was a very pleasant one, and turned out, as all Electric Club performances do, a complete success.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.,
BOSTON, Mass., June 20, 1891.

Mr. George A. Cutter, of Chicago, was in town last week.

The Rowell Patent Safety Stop is to be applied to the Boston, Revere Beach & Lynn Railroad at once.

The Schuyler Electric Company, of Middletown, Conn., is building a large addition to its works, which was made imperative by increased business.

Mr. D. A. Andrews, Jr., has returned from a delightful pleasure trip, the sequel of which was the fine June weather so conducive to matrimony and pleasure. The many friends of Mr. Andrews will wish him much joy in this new venture.

Montreal Meeting.—There is every indication of a very large attendance and exhibit at the National Electric Light Convention to be held in Montreal in August. This will be particularly so of New England. Everybody can be assured of a hearty welcome by our Canadian friends and if they do not enjoy themselves the fault will be their own. C. A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY TRUST BUILDING, PHILADELPHIA, June 20, 1891.

The Heisler Electric Light Company, of Philadelphia, through its agent, the Belton Electric Company, of Belton, Tex., has just sold a complete electric lighting plant, to be installed at Hallettsville, Tex.

M. S. Sharpleigh, agent for the Electrical Supply Company, of Ansonia, Conn., has removed from 112 South street to 244 Arch street, Philadelphia, where he has been able to obtain much more commodious quarters than in his former office.

The Harrison Safety Boiler Company, of Germantown Junction, Philadelphia, Pa., has just shipped a 600 h. p. boiler to Chicago for use in the office of the Chicago *Herald*, and has also recently sent four 150 h. p. boilers to Toledo, O., to the Consolidated Street Railway Company.

Mr. J. W. Parker, of 38 South Fourth street, Philadelphia, agent for the Ball Engine Company, of Erie, Pa., has sold to the Allegheny and Bethlehem Rapid Transit Company a second 150 h. p. engine, also one 40 h. p. engine to the Luxury Tobacco Works, Philadelphia, and a large number of C. & C. motors, for which last he is also the Philadelphia agent.

Pittsburgh, Pa.—The Birmingham Traction Company, which has been vigorously pushing for some months the construction of an electric line to take the place of its horse-car system, began operations last week. A trip from the Birmingham stables of the company to Union Station, Pittsburgh, was made in 15 minutes, while the horse cars consumed forty-six minutes in covering the same distance. The new line is three and a half miles in length. Work upon it was commenced a year ago and carried on without interfering with the horse-car traffic. Considerable delay was experienced in remodeling the Smithfield bridge over the Monongahela River to meet the requirements of the new system; otherwise the horses would have been retired some time ago. Thirty cars are ready for service, ten of which are equipped with Edison motors and ten with motors manufactured by the Short company. The Birmingham line is the straightest in the city, there being only two curves in the road from the Union Station in Pittsburgh to the terminus in Birmingham. The power house is equipped with two 500 h. p. engines and four generators of 200 h. p. each. The switchboard is of polished slate, and makes a favorable comparison with any in the cities of Pittsburgh and Allegheny. Edison generators are used. The power-house building is 80 feet square. It is wholly fireproof. Immediately behind it is the boiler room, 50 × 100 feet It is fitted with Babcock & Wilcox boilers of 1,000 h. p. capacity. Adjoining the boiler room is the machine and repair shop, 100 feet square. The car house is 360 feet long by 60 feet wide. The cars now in use were manufactured by the Gilbert Manufacturing Company, of Troy, N. Y., and are 32 feet in length and weigh 10 tons each. Mr. P. C. Cheney, electrician of the Willamette Falls Electric Light Company, of Portland, Ore., is a visitor to the East. Mr. Cheney has been spending some time in Pittsburgh, gathering information with regard to the Westinghouse system of lighting, which is used in the Willamette company's station. Mr. J. H. Gates, of the Westinghouse Electric and Manufacturing Company, recently returned from a lengthy visit to the northwest Pacific coast. Mr. Gates reports that there is great activity in that region of the country in the introduction of electricity for lighting and power uses.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, June 20, 1891.

Mr. W. D. Chapman, general manager of the Akron Electrical Manufacturing Company, was a welcome visitor in Chicago this week.

Mr. George F. Card is completing a new coal mining machine that will be placed on the market by the Fort Wayne (Ind. Electric Company.

The Columbia Incandescent Lamp Company, of St. Louis, Mo., has secured the services of several first-class agents as representatives in various sections of the country.

Mr. Charles T. Yerkes, of Chicago, states that all his outlying lines will be equipped with an electric system, especially on the north side, where the cable system will not be extended.

Messrs. Leonard Schaefer & Co., of 1,912 Olive street, St. Louis, Mo., are placing on the market the "Schaefer" porcelain ceiling cut-out rosette, which has won many words of praise for its reliability from experienced wiring contractors.

Dr. C. E. Wright, superintendent of the Central Indiana Hospital for the Insane, at Indianapolis, Ind., Dr. Z. H. Hauser, of Columbus, Ind., and J. L. Carson, of Fairland, Ind., are in Chicago looking into the merits of the different electric lighting systems preparatory to installing one in the insane asylum. F. DE L.

SOUTHERN NOTES.

NORFOLK, Va., June 20, 1891.

Ozark, Ala.—An electric light plant will be located here.

Newton, N. C.—An electric light plant is to be established here at once.

Greenville, Ala.—It is reported that an electric light plant will be built.

El Paso, Tex.—A party of eastern capitalists is to organize a stock company to build a new electric light plant.

Rosedale, Miss.—The City Council has granted a franchise to a company for the erection of an electric light plant.

Westminister, Md.—A stock company is being organized here by Mr. C. E. Fink to erect an electric light plant.

Norfolk, Va.—It is reported that the Merchants and Miners' Transportation Company will erect a new electric light plant

Charleston, S. C.—It is reported that the organization of a stock company to erect a new electric light plant will soon take place.

Mobile, Ala.—The Mobile Street Railway Company has been granted a franchise by the City Council to operate its lines by electricity.

The Eureka Springs (Ark.) Electric Light and Street Railway Company has been incorporated, with a capital stock of $30,000.

Nashville, Tenn.—The capacity of the power plant of the Citizens' Rapid Transit Company has been increased to the capacity of 250 h. p. It was formerly of 100 h. p.

Richmond, Va.—E. R. Hix & Co., of Baltimore, Md., have been awarded the contract to place electric lights in the building of the Masonic Temple Association.

Lynchburg, Va.—The contract for the erection of the Rivermont Company's electric light plant has been let to the Edison General Electric Company, of New York City.

Atlanta, Ga.—Lightning played havoc with the Atlantic and Fort McPherson electric railway recently. The plant was greatly damaged. Passenger traffic was stopped for several days.

Cumberland, Md.—Pittsburgh (Pa.) parties have leased the old Gephart foundry and machine shop, and, it is reported, will operate the plant for the manufacture of electrical supplies.

Paris, Tex.—The contract for the erection of the electric light plant here has been awarded to the Paris Gas and Electric Light Company. The latter company wishes estimates on machinery.

Graniteville, S. C.—The Cotton Shoal Electric Light and Power Company has been incorporated with a capital stock of $10,000. W. A. Edwards and Alvin Etheridge are the incorporators.

Baltimore, Md.—An electric power plant will soon be erected by the North Avenue Electric Railway Company, at North and Singluff avenues. The plant will include 125 h. p. engines and two 80,000 Watt generators.

Asheville, N. C.—The Asheville and Sulphur Springs Land company will erect an electric light plant here. The officers of the company are: J. D. Murphy, president; J. H. Tucker, vice president, and Henry Sheppard, secretary.

Hallettsville, Tex.—The city will erect the new electric light plant, and is soliciting bids for the erection of the same. The engine and dynamo will have a capacity of 300 incandescent lights, which will be distributed over four miles of circuit.

Richmond, Va.—Four of the dynamos at the power house of the electric street railway were recently struck by lightning and their armatures destroyed. Considerable damage was done to the plant, but no one was injured. Several cars were also struck.

Raleigh, N. C.—Arrangements and contracts have been made for the erection of Raleigh's new electric street railroad. The power

plant will be run with two 80 h. p. engines, and when completed the city will have as fine an electric railway as any in the country.

Staunton, Va.—Messrs. Reeves Cott, of Staunton, and A. T. Holtzman, of Washington, D. C., have applied for a franchise to build an electric street railway here. They have deposited $250 to be forfeited if the work is not commenced by the 1st of October, 1891.

Colorado, Tex.—The city has just completed its new system of electric lights, and everything work to perfection. Every business house and quite a large number of residences are now supplied with electric light. One hundred and fifty lamps are already in use.

Augusta, Ga.—The Augusta Electric Street Railway Company celebrated its first anniversary on the 15th of the month. To commemorate the event President Dyer sent down Broad street one of the old "hay burners," closely followed by one of the company's fine electric cars, to demonstrate the difference in the mode of traveling in Augusta one year ago and at the present day. The streets were thronged with people, loudly cheering as the "electric schooner" sailed by. Two other cars, both of them handsomely decorated with bunting and flags, were also run before the admiring gaze of the citizens of Augusta. The first car was one of the old mule cars, drawn by two little mules, and directly behind was a brand new electric car, twice the size of the former car. On the old car were these words: "Rapid transit among the ancients, June 15, 1890. Cemetery to Arsenal; time one hour; fare 15c." On the electric car was: "Rapid transit, June 15, 1891. Cemetery to Arsenal; time thirty-five minutes; fare 5c."

V. N. B.

ENGLISH NOTES.

(From our own correspondent.)

LONDON, June 3, 1889.

Electrical Exhibitions.—In addition to the International Electrical Exhibition at present in full swing at Frankfort and the exhibition announced to be opened at the Crystal Palace in the autumn, the little western town of Taunton (the pioneer town of electric lighting in the west of England) proposes to have an electrical exhibition of its own. It will be furnished with the usual concomitants of electrical omnibuses, launches and art fittings.

Electric Light in Factories.—The following extract from the last report of Her Majesty's Chief Inspector of Factories is perhaps one of the most striking testimonies to the hygienic value of the electric light that has yet been received: "The introduction of the electric light into factories," says the inspector, "adds very much to the health of some occupations and to the comfort of all." Mr. Beaumont, inspector for Bradford, has made a comparison of the temperatures in a wool-combing shop when lighted by electricity and gas. This comparison shows that the average temperature when lighted by electricity was 95 degrees Fahr. and when lighted by gas 105 degrees.

Electricity in Mines.—At a recent meeting of the Federated Institution of Mining Engineers a paper was read describing an electric safety apparatus for miners' cages. It was stated that although great advances had been made in recent years in nearly every branch of mining engineering we were no better off to-day for reliable safety cages than we were 20 years ago. During the past 10 years there had been an average of nearly 10 deaths per annum from the breakage of ropes and chains in shafts. The electrical apparatus in question consists in the use of the hauling rope as a means of conveying electricity to four electromagnets on the cage, each of the magnets sustaining a gripping cam. On the fracture of the rope and the consequent breaking of the electric circuit the cams drop into guides.

Opening of the Notting Hill Company's Central Station.—On Saturday afternoon last Prof. Crookes presided at the opening of the Central Station of the Notting Hill Electric Light Company. This company supplies a fairly rich residential district situated in the north of London. The plant at present laid down is only sufficient for 10,000 eight c. p. lamps and consists of Willans engines coupled direct to Crompton dynamos, the dynamo power being supplemented by two 56-cell Crompton Howell batteries. The ultimate capacity of the station will be 50,000 lamps connected. It is the intention of the Notting Hill company to immediately build another station for the southern portion of the district allotted to it. The distribution is carried out on the three-wire system. Crompton culverts with copper strip conductors are employed wherever space permits, highly insulated cables drawn into culverts being used elsewhere.

The Board of Trade and Municipal Electric Lighting.—After having come into collision with private electric lighting enterprise, the Board of Trade is performing the same feat in connection with municipal enterprise. A few weeks ago it raised the anger of the Barnsley municipality by suddenly demanding the insertion in the municipal Provisional Order of a clause insisting on underground wires, which immediately rendered the introduction of the light impracticable at Barnsley, where the price of gas rendered such an expensive procedure out of the question. At Newcastle also, a day or two ago, a petition was sent to Parliament against the electric lighting bill of the local company, the principal objection to the bill being that in its present form the municipality would not be given complete control over overhead wires, and that the Board of Trade wished to intrench upon municipal rights in several directions. It was stated that there would not be the slightest difficulty in coming to an agreement with the company, and that the matter was really a fight between the municipality and the Board of Trade.

LONDON, June 10, 1891.

Copper.—The continuous rise in the price of copper, which now stands at over £55 per ton, and the continual diminution of the stocks in hand, has given rise to rumors that a modified form of "corner" is again being worked.

The Overhead Trolley System and the Telephone.—The German postal authorities are, I hear, about to institute legal proceedings against the Allgemeine Elektricitäts Gesellschaft, owing to the disturbance caused in the telephonic circuits at Halle by that company's cars.

Thames Electric Launch Fleet.—The fleet of electric launches on the Thames, which must now number nearly twenty, had two additions made to it last week by the floating of the "Glowworm" and the "Myiomi," each of which is capable of carrying some 40 passengers.

Military Telegraphy.—A smart feat was performed the other day by the Telegraph Battalion of the Royal Engineers, which has been running a military field telegraph line from Aldershot to Chatham. The first section, 50 miles in length, was erected in less than 30 hours, light bamboo poles being used throughout.

A Chance for Electric Traction.—A brilliant opportunity for the introduction of electric traction will shortly occur in the north of London, where, in consequence of a vigorous agitation set on foot by property owners, the Board of Trade has refused to grant a renewal of license to use steam cars. The steam cars will have to cease running on and after June 15.

City and South London Railway.—The introduction of penny fares combined with the omnibus strike has led, I hear, to terrible overcrowding on the City and South London Railway, although extra trains have been run to meet the emergency. The South of London is, however, so largely dependent on "busses' rush. that no amount of extra trains would be likely to cope with the

Electric Tanning.—The Worms and Bâlé patent for tanning hides by electricity in conjunction with *rotating* drums, which was invalidated on a point of law, has just been rehabilitated by a special Act of Parliament. By the judgment given in the action of the British Tanning Company v. Groth, the Worms and Bâlé patent does not, however, extend to tanning by electricity when the hides are rotated in a *stationary* drum. This patent was invalidated owing to a misconception of a section in the International Patents Act, so its revival is just, although somewhat unusual.

The Close of the Scientific Society Season.—The close o what may be termed the "scientific society season" is being marked this year by the reading of a large number of interesting papers. Last week Dr. Lodge treated the Royal Society to a lengthy accoun of the early experiments made by him in connection with lightning discharges. These experiments were of special interest, as they dealt with the subject of electromagnetic waves, and clearly show how very near Dr. Lodge was to forestalling Hertz's epoch-making discovery. At the same meeting of the Royal Society a paper was read by Profs. Ayrton and Perry and Dr. Sumpner on "Quadrant Electrometers." These gentlemen have carried out long and much needed experiments with a view of ascertaining the cause of and discovering a remedy for the inaccuracy of these instruments, the deflections of which, it has for some time been known, do not by any means follow the law generally given in the mathematical text books. The chief cause of the peculiar behavior of the quadrant electrometer is, according to the authors of the paper, the electrical action between the guard tube and the needle, and the slight tilting of the needle which occurs when high potentials are applied to the instrument. This week also there are numerous interesting papers, covering nearly the whole range of electricity, down for reading before the Royal and Physical Societies, while next week Lord Rayleigh will deliver an address before the Prince of Wales at the Royal Institution in celebration of the hundredth anniversary of Michael Faraday's birthday.

Electric Lighting at Glasgow.—As I have reported in previous letters, there has been considerable agitation in connection with the electric lighting question in Glasgow, and after much debate the corporation has decided to spend some £50,000 on a low-tension system for a small area in the centre of Glasgow. The agitation in the local press has arisen from the fact that the electric light committee of the corporation has been obviously led by the nose by a distinguished advocate of and contractor for low-tension plant, whom they unfortunately engaged as consulting engineer, and an extremely able series of articles exposing the inadequacy of the proposed system and the impropriety of employing a contrac tor as an adviser has appeared in the Glasgow *Evening News*. There seems but little doubt as to the desire of the Corporation to do the proper thing, and it is, therefore, all the more regretable that they should have been misled in the manner they have. Indeed, with the exception of Bristol, municipalities seem to have been exceedingly unhappy in their dealings with the electric light. Bradford adopts a plain two wire system; Dublin advertises for tenders, and owing to the peculiar manner in which they are dealt with is threatened with litigation, and Brighton, a town which one would think eminently suitable for transformer working, also prefers low tension. In connection with the electric lighting question, the *Journal of Gas Lighting* throws out the suggestion that the Corporation should make use of its gas mains to supply a number of small sub-stations, gas engines driving dynamos being employed. Provided the cellars to which the *Journal of Gas Lighting* alludes can be obtained at a fair rent and in convenient positions, there is little doubt that such a scheme would, perhaps, prove the cheapest after all in the case of Glasgow.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Electric Heating.—Will you please tell me what are the principles of some of the electrical heating systems? I have seen several papers upon them, but I would like to have a better idea of them.

J. E. G.

We cannot see but that the papers to which you refer will give you the most thorough explanation of these various systems. The principle underlying all electrical heating systems is the simple heating of high resistance wire by heavy currents, and the chief difference between any two "systems" of electrical heating lies only in the assembling of the parts into various designs in an attempt to arrive at commercial efficiency. Dewey's refrigerating system, the reverse of these, is a most ingenious use of the "Thomson effect," and is about the only thing to be spoken of in the sphere of electrical heating or cooling systems which can bear any but the most simple explanation. See THE ELECTRICAL WORLD of last week.

Motors on Accumulator Circuits.—I am desirous of installing an 1-8th h. p. motor, with which I desire to run a dentist's engine—a load about equivalent to an ordinary sewing machine. (1) Is such a motor powerful enough? (2) Can I get energy enough from a battery of storage cells charged by a gravity cell battery placed in series with the former battery? (3) Can I charge the cells from a 35-light arc dynamo electric machine? (4) What is meant by the term "ampère hour"? Is it determined by ordinary time?

S. H. M.

(1) Yes, though perhaps a ¼-h. p. motor would be more satisfactory. (2) We advise you not to try this method. The results are certain to be unsatisfying. (3) Yes, but you must place the operation in the hands of some one thoroughly acquainted with the work. The best way would be to have installed a small arc-circuit motor if the line is near at hand. (4) One ampère of current flowing for one *ordinary* hour equals one ampère hour, or one-half ampère flowing for two hours equals one ampère hour, and so on.

Emery and Commutators.—I have read an article upon the care of dynamos wherein the writer advises the use of fine emery cloth for the smoothing of commutators. I have been advised by the manufacturers of our dynamo to never use emery for the above purpose. (1) What is the best way to smooth commutators? (2) Can a house be so wired that the circuits will admit of the use therewith of any of the following systems: Westinghouse, Thomson-Houston, Edison or Heisler?

A. A. W.

(1) Emery cloth can be used, but manufacturers must advise for the many who do not realise that great care and cleanliness are most important factors for the welfare of their machines in the hands of the untutored masses. We have found fine sandpaper to be much more satisfactory than emery cloth, but one must be watchful that no dust or dirt is allowed to accumulate. (2) The proper way is to wire your house for the voltage of the system to be used; but if the house is wired for the *lowest* voltage used in the systems mentioned the circuits will do quite well for systems of higher voltages. However, a useless waste of copper occurs when a 110-volt system is used in connection with 50-volt circuits. As to the Heisler system, requiring series wiring, the ordinary multiple system circuits will not meet its special requirements.

News of the Week.

THE TELEGRAPH.

Southern Extensions.—The telegraph line between Chattanooga and Garden, Tenn., along the Chattanooga Southern Railroad, is to be completed at once.

Developments in Telegraphy.—A paper read before the Canadian Society of Civil Engineers by Mr. D. H. Keeley, of Ottawa, Can., a member of that society, has just been published in pamphlet form. Its title is "Developments in Telegraphy, Way Wires Multiplexed and Interchangeable." The paper is a very interesting one for those engaged in any branch of telegraphy, and who are desirous of keeping up with the times in regard to the numerous and important developments that are taking place. Appended to the paper is the discussion which took place after it was read before the society.

Wheeling, W. Va.—The Central District and Printing Telegraph Company began operations in Wheeling, through its superintendent, M. R. Wolff, in the summer of 1890, with less than 25 subscribers to its central telephone exchange. Its catalogue of subscribers for June, 1891, shows over one thousand names, including the adjacent cities of Bellaire, Bridgeport, Martin's Ferry, O., and Moundsville, W. Va. Wheeling has telephonic communication with about two hundred cities, towns and hamlets in West Virginia, Ohio and Pennsylvania. Lines are now under construction which will connect Clarksburg, Grafton, Fairmont and Morgantown, and from thence an extension will be built within a year to Waynesburg, Pa., where the company has lines running to Wheeling, Washington and Pittsburgh. When this line is completed Wheeling will have connection with a large number of the towns in the interior of West Virginia. The American Long Distance Telephone Company, now doing business between Boston, New York, Albany, Philadelphia and Buffalo, will in a few weeks complete a line to Pittsburgh.

THE TELEPHONE.

Irvington, N. J., is to have a long distance telephone system.

Reading, Pa.—A telephone line 100 miles long is being strung between Reading and Columbia, Pa.

New Haven, Conn.—The line between here and New London is being rebuilt and a new metallic circuit added.

Bridgeport, Conn.—The thunderstorm of last week was felt very severely, over 75 annunciator drops being burned out.

Mr. E. A. Smith, manager of the Southern New England Telephone Company at Meriden, Conn., and formerly chief operator at New Haven, was married to Mrs. Anna Murray, of New Haven, at Newark, Conn., Wednesday, June 10.

Ridgefield, Conn.—The Southern New England Telephone Company is building a new telephone exchange at this popular summer resort. It will be equipped entirely with single metallic circuits and long-distance instruments.

Mr. Morris F. Tyler, president of the Southern New England Telephone Company, has recently bought a magnificent summer residence situated on Woodbridge Heights, eight miles from New Haven, Conn. It commands a beautiful view of New Haven and vicinity, and Long Island can plainly be seen on the horizon.

THE ELECTRIC LIGHT.

Edinburg, Ind., is to negotiate for electric lighting.

Hamilton, O., is again pushing the electric light question.

Cambria, Wis., is to receive bids for an electric light plant.

Ladoga, Ind., is to have an electric light plant this month.

Dunkirk, N. Y.—The city paid $180 for its May street lighting.

Oneida, N. Y., is to let its street-lighting contract for a term of five years.

Middletown, Conn.—The electric light plant is to be greatly enlarged this year.

Santa Fe, N. Mex.—The capacity of the electric light plant is to be doubled this month.

Orange City, Ia., has granted a twenty year franchise to its new electric light company.

Corning, N. Y.—The Corning Gas Company is installing an additional 50-light arc dynamo.

Arkadelphia, Ark., is now erecting its electric light plant, and expects to have the lights this fall.

Joliet, Ill., is still advertising for bids for arc lights for street lighting and for a municipal electric light plant.

Denver, Col.—A new bidder for the city lighting this year is the Arapahoe Electric Company just incorporated with a capital of $500,000.

Marquette, Mich.—The electric light plant will be erected some time this summer. There has been some delay in getting the work started.

Pittsfield, Mass.—The Pittsfield Electric Light Company is extending the street light service under the direction of the board of public works.

Fort Wayne, Ind.—The city has accepted the local electric light company's bid for street lights for the coming year at $125 a light per annum.

Sault Ste. Marie, Mich.—Since the electric light was introduced in the saw mill the output has been 200,000 feet of lumber every 24 hours.

Milton, Pa., has contracted to have 45 arc lights burn every night till 1 o'clock, at a cost of $62 per year each, or an aggregate cost of $2,700 per year.

Pontiac, Mich., has sent out a committee of aldermen to visit some of the State cities with a view to determining upon a system of electric lighting for the town.

Georgetown, Colo.—The Electric Light and Power Company will commence operations this week by lighting the city, private

residences, and also being ready to furnish power to the neighboring mines.

Sullivan, Ind.—The city council has granted a franchise to establish an electric light plant in that city, and has rented light for 10 years at $80 per light per year.

Navasota, Tex.—The contract with Col. E. L. Bridges for an electric light plant has been formally accepted by the city council and work will commence immediately.

Vandalia, Ill.—A heavythunder storm last week wrought considerable damage to the electric light station. Mr. E. Rode was knocked senseless by one of the discharges.

Tioga, Pa.—The Diamond Electric Light Company, of which Chief Dixey, of the Bureau of City Property in Philadelphia, is president, is erecting a large electric light plant.

Butler, Ind., is now open for receiving bids for an electric light plant unt l July 2, the bids to be made on a basis of at least 20 lights, with privilege of more at same rate, of 2,000 c. p.

Hastings, Mich. The Peninsular Company, of Grand Rapids, Mich., has been awarded the contract to erect an electric light plant for the town. The station is to be in operation this fall.

Albia, Ia.—The city council last week passed the ordinance granting G. W. Hunt & Co. the franchise to erect a combined water and electric light plant, the city to rent same from the company.

Knightstown, Ind.—The city council has appointed Messrs. J. W. Locke, A. E. Carroll and J. D. Maple the committee on electric light, who will immediately take active steps toward choosing the system to be used.

Butte, Mont.—The plant of the Rocky Mountain Electric Light and Supply Company, which has met with so much delay, is now to be rapidly pushed to completion. The company is to bid next year for the city lighting.

The Rutland Electric Light Company, of Rutland, Vt., of which Mr. M. J. Francisco is the president, has just moved into handsome new offices, and last week gave a reception celebrating its removal from the old quarters.

Peabody, Mass.—A special town meeting last week voted, 614 to 87, that it is expedient to exercise the authority conferred by the recent act of the Legislature to establish a plant for the manufacture and distribution of electricity.

Lake Charles, La.—The electric light plant installed under the direction of Messrs. Landry & Co. has just been completed and put in operation with ten municipal arc lights and a large number of commercial lights, both arc and incandescent.

Seabright, N. J.—The disastrous fire of last week destroyed the local telephone and telegraph systems and much trouble was caused by the delay in sending out fire calls. A lineman of the telephone company, however, climbed a pole and sent out the calls.

Inland Steamer Plants.—The Fisher Electric Company has re-equipped the steamer City of Detroit with a 650-light incandescent plant. The company has also completed a 250-light plant on the new steamer City of Toledo, to run between Toledo, O., and Put-in-Bay, O.

Milwaukee, Wis.—The city council last week by a two-thirds majority passed an ordinance granting the Milwaukee Electric Power and Lighting Company the right to extend its wires to all parts of the city, thus enabling it to enter into competition with the Badger Electric Company for the city lighting, when a new long term contract is to be entered into next fall.

Marquette, Wis., runs its own electric light plant. During the year ending Dec. 31 the income amounted to $7,272.26, while the expenses footed up $6,154.91, leaving a net income of $1,117.35 above all running expenses and interest charges. The light was furnished to consumers at $60 per annum for arc lights and 40 cents per month for sixteen candle power incandescent lights.

For Naval Electric Plants.—Bids were opened at Washington last week, at the Navy Department, for electric light apparatus for the United States vessels, including the Maine and the Texas, building at the Brooklyn and Norfolk Navy Yards. The proposals were as follows: Edison Electric Company, New York, generating sets, $67,327; Edison Electric Company, New York, including spare parts, $80,470.08; electric search light material, $41,659.20; signal apparatus, $8,160. The Thomson-Houston Company, Boston, generating sets, $69,000; the Thomson-Houston Company, Boston, generating sets, including spare parts, $88.650; electric search light material, $39,549; signal apparatus, $7,600. The time for completion is about five months.

The Pittsfield (Mass.) Electric Company has done its patrons an excellent service in the publication of what it terms "Plain Talks About Incandescent Electric Lighting." The ground covered includes a description of an electric generator, of the terms volt, ampère and watt, a chapter giving details of incandescent lamps, one on converters, another on safety devices, and a number of others fully as interesting, and all of extremely practical value to the user of incandescent light. These chapters were written by Mr. W. A. Whittlesey, manager and treasurer of the company. The pamphlet, which by the way is neatly printed and arranged, also contains the company's rates for incandescent and arc lighting, and for electric motors.

Oakland, Cal.—The bid of the Oakland Gas, Light and Heat Company, which has been accepted by the city for street lighting, is as follows: "For the lighting of the electric street lamps, each and every night until 1 A. M., at the rate of 40 cents per lamp per night, and for the lighting of the public buildings in the city of Oakland by gas at the rate of $2 per 1,000 cubic feet, meter measurement and for public buildings by electricity at the rate of $12 per month for each arc lamp of 2,000 c. p., to burn each and every night until 12 o'clock, and for incandescent electric lamps for public buildings where said buildings are situated on the line of the company's wires carrying said incandescent current, at the rate of $1.50 per month for each lamp of 16 c. p., said incandescent lamps to burn each and every night until 12 midnight."

Isolated Plants.—The Thomson-Houston Electric Company reports the following sales of arc apparatus: Aluminium Carbon Company, Lancaster, Pa., 6 lights; U. S. Immigration Depot, Ellis Island, New York Harbor, 40 lights; Palisades Amusement Company, 150 lights. Isolated plants, incandescent apparatus: H. K. Hartzell, Catasauqua, Pa., 50 lights; Fort Hamilton Brewing Company, Fort Hamilton, N. Y., 50 lights; Bradbury-Stone Storage Battery Company, Lowell, Mass., 100 lights; National Transit Company, Parker's Landing, New York, 100 lights; E. Copeland, New York, 100 lights; Henry Adams, Rockville, Conn., 150 lights; Cutler Bros., Wakefield, Mass., 150 lights; Blue Ridge Inn, Mt. Airy, N. C., 200 lights; Wainwright Real Estate Company, St. Louis, Mo., 2,000 lights; Agnes Scott Institute, Decatur, Ga., 200 lights; Croton Magnetic Iron Mine, Brewster, N. Y., 300 lights; H. C. F. Koch, New York, 800 lights; W. Engle & Co., Orono, Me., 50 lights; Cleveland Ship Building Company, Cleveland, O., 100 lights; Consumers' Brewery Company, New York, N. Y., 400 lights; Manf. Investment Company, Madison Me., 400 lights; A. O. Couch, New York, 200 lights; W. E. Anderson, Blacksburg, Va., 400 lights; Washington Loan and Trust Company, Washington, D. C., 800 lights.

THE ELECTRIC RAILWAY.

Asbury Park, N. J.—An early morning fire last week destroyed the power station and engine-room of the Seashore electric street railroad, owned principally by Lenox Belknap, of New York City. The station contained sixteen dynamos and eight engines, and the loss is about $50,000; the insurance is $20,000. The company owned and operated four miles of railway, belting the entire town.

A Fender for Electric Cars, intended to operate precisely as the ordinary fender on a steam railway locomotive, has just been patented by Mr. Arthur B. Hitchcock, of Boston, Mass. The feature most worthy of notice is the fact that while the car body oscillates vertically to an extent as great as seven inches, the fender remains at a given fixed point, about two and one-half or three inches from the rail.

Fall River, Mass.—The Board of Aldermen has granted a location for an electric freight railway, with a capital of $1,000,000. Boston and Fall River capitalists furnished the money, and will build a belt line, carrying freight between the mills and the Old Colony tracks, fifteen miles, over private land. The board also granted the Globe Street Railway Company's petition to introduce the trolley system on its present road, thus enabling it to be largely extended.

The Attleboro Steam and Electric Companies' Consolidation.—The final negotiations were closed last week by which Mr. Louis W. Dillon became general superintendent of the Attleboro, North Attleboro and Wrentham Street Railway and the North Attleboro Steam and Electric companies jointly. This arrangement secures what has long been demanded, a centralized direction of the business of the two companies. Mr. Dillon has been associated with the electric light company since its inception and is fully conversant with electrical matters in all their details, so that he brings to the joint management of the mechanical portion of the companies' affairs just what they require to insure the smooth operation of the road and lights. Mr. George F. Goe will be assistant superintendent of the railway company, relieving the general superintendent of the minor details of the car service.

LEGAL NOTES.

Trolley vs. Telephone in Ohio.—The Ohio Supreme Court has decided in effect that when telephone wires and street railway electric wires cannot be operated together without damage to telephone service, the latter must take the consequences.

Street Railway Infringement Suits.—Infringement proceedings are about to be commenced in the U. S. Court at Kansas City, Mo., against the Interstate Rapid Transit Co., which is using the Thomson-Houston system of railway apparatus. This suit is brought by Mr. John C. Henry, of Temple Court, New York City, and the points at issue are those embodied in the claims of Mr. Henry's patents Nos. 345,845 and 424,298, and relates to the cross-suspension, or span-wire system, the under-running trolley, the arrangement of circuits in double multiple, insulated feeders, curve construction and the form of trolley insulator.

PERSONALS.

Mr. Leo Daft, it is reported, is to remove to Tacoma, Wash., to engage in the manufacture of electric motors.

Dr. Louis Duncan, of Johns Hopkins University, sailed for England on Wednesday of last week.

Capt. Willard L. Candee, of the International Okonite Company, will sail for Europe July 1 on the Teutonic.

Mr. L. A. Bethel, of the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., is engaged at present for the company in Los Angeles, Cal.

Mr. Charles A. Schieren, who is well known in connection with his perforated electric leather belting business, has been chosen vice-president of the Hide and Leather National Bank, a new institution lately organized and which opened for business on June 17 for the first time.

MISCELLANEOUS NOTES.

The Pittsburgh (Pa.) Electric Club is to hold a meeting at the Monongahela House in Pittsburgh for the purpose of deciding upon the location for a club house.

Westinghouse Employes' Picnic.—The employés of the Westinghouse Electric and Manufacturing Company held a pic nic at Rock Point last week. Fifteen carloads of them went down at 8:30 in the morning and a delightful time was had.

San Francisco, Cal.—Work has begun on the Metropolitan railway, at the corner of Page and Clayton streets. This is the new electric railroad proposed to be constructed from Market, Mason and Turk streets to the Olympic Club grounds, thence through Southside and along the Boulevard to Golden Gate Park. The construction of this line may have a good effect on the area of unoccupied land lying to the south of the park.

The Siemens & Halske Exhibit at Frankfort.—We have received from the well known German house of Siemens & Halske a catalogue of its exhibit at the International Electric Exhibition at Frankfort, which is now in progress. The catalogue is in the shape of a bound volume and contains 150 pages. The apparatus exhibited is quite fully described, and the description is accompanied by illustrations. The variety of apparatus exhibited is quite noticeable, as it covers the various branches of electric lighting, power, transmission, signaling, telephony, telegraphy, etc. The catalogue is certainly a credit to the firm issuing it.

"The Metal Trades Directory for New England and New York State" has just been issued by Price, Lee & Co., publishers, of New Haven, Conn., and contains alphabetical and classified lists of manufacturers and dealers in hardware machinists and machinery manufacturers, engine builders, boiler makers, iron and brass founders, etc. It will be found a valuable reference book for electrical supply dealers, who, of necessity, have extensive dealings with metal workers and manufacturers in that section of the country covered by this directory. It contains a very complete list of manufacturers of and dealers in electrical appliances and electrical metal goods of various kinds.

"The Cleaning and Sewerage of Cities" is the title of a book just issued from the press of the Engineering News Publishing Company, New York City, and is a translation of a German work upon this subject by R. Baumeister, the translator being Mr. J. M. Goodell, the associate editor of *The Engineering News*. While containing nothing which is exactly electrical in its nature there is much information in it which is necessary for the electrical engineer who has to do with underground work in connection with electric railways and telephone and telegraph subways in large cities, where the matter of proper drainage is an important item On this subject it will be found to contain much practical information.

Industrial and Trade Notes.

The Midland Electric Company, of Denver, Colo., has removed from its former stores, Nos. 1,517 and 1,519 Lorimer street, to more commodious quarters at 1,616 and 1,618 Seventeenth street, where they will continue to carry in stock a great variety of electrical supplies and machinery.

Messrs. Hatzel & Buhler, of 29 West 26th street, New York City, the agents of the Detroit Motor Company, have just received from the latter company a large shipment of one-quarter horse power motors. These motors can be run at two speeds regulated by field coil commutation, thus admitting of economy of current on the part of the user.

The Eastern Electric Light and Storage Battery Company, of Lowell, Mass., has issued a catalogue giving the details of construction of the Sorley storage battery, of which this company is the manufacturer. The pamphlet also contains a list of supplies for electric lighting and power installations for which the company acts as agent.

The Berlin Iron Bridge Company, of East Berlin, Conn., has designed and built the new machine shop for the Ball & Wood Company, at Elizabethport, N. J. The central portion of the building is 40 feet wide, with a wing on each side 20 feet in width. The entire central portion of the building is served by a traveling crane operated by electricity.

The Card Electric Motor and Dynamo Company, of Cincinnati, O., has issued a very handsome catalogue describing very fully its constant potential and constant current dynamos and motors for all classes of work. The machines and their component parts are very completely illustrated, and the cuts, together with the clear descriptions given of them, convey to the reader an accurate idea of the construction of the company's apparatus.

The Novelty Electric Company, of 50, 52 and 54 North Fourth street, Philadelphia, Pa., has issued its very handsome and complete catalogue and price list, "No. 15." Upon its front cover appears the title, "Everything Electrical," and it would be useless to attempt a better expression of what is to be found within the book. The cuts are numerous, are very clear and well drawn. The Novelty Company has the sole agency for quite a number of electrical supply articles.

The National Electric Company's anti-induction wire, which is to be used in Boston, Mass., in the municipal alarm and telegraph system, consists of a core covered with rubber and woven material. Over this there is a thin strip of thoroughly annealed iron wound several turns to the inch and over all another layer of woven insulating material. This strip is used as the return conductor, thus making a complete metallic and thoroughly insulated circuit combined into one line. The iron strip also acts as a protection against abrasion, thus preventing ground circuits going through trees, etc. An elaborate practical test was made recently at the Beachmont power station near Boston by Mr. Charles W. Putnam of the company.

Brass-Covered Paper Tubes for interior wiring, the latest novelty introduced by the Interior Conduit and Insulation Company, seem to be meeting with much success. Mr. E. H. Johnson thinks they will solve the difficulties that have been encountered in special cases. A tube that is light and cheap, waterproof and acidproof, and at the same time fireproof and a good insulator, is what the Interior Conduit and Insulation Company has aimed to furnish. It was found in practice, however, that the ordinary paper tubes could not withstand Portland cement, for instance, and that for the ceilings of parlors and the like something a little more ornamental was needed. The thin brass covering adds practically nothing to the size of the tube, and as it can be handsomely polished it does not look in the least out of place in a parlor. So far as expense is concerned, the brass-covered tube does not cost so much more than the ordinary paper tubes—perhaps twice as much—and is well worth the difference.

Parmly, Mitchell & Company, of 18 Cortlandt street, New York City, a firm composed of well-known electrical men, recently organized, are representatives of the Columbia Incandescent Lamp Company, of St. Louis, Mo., for the Middle States east of Rochester, N. Y., and local sales agents for well-known manufacturers of sockets, switches, cut-outs, motors, etc., and are also general wholesale dealers in electrical supplies of every description. Mr. C. F. Parmly was engaged for seven years with the Marr Construction Company and the North American Construction Company, and during that time supervised the installation of a large number of central stations, both arc and incandescent. Mr. P. W. Mitchell, another member of the firm, was also employed with the North American Construction Company and afterwards with the Electrical Supply and Construction Company, of Pittsburgh. Mr. C. D. Doubleday, the third member of the firm, was for three years New York manager of the North American Construction Company, and its predecessor, the Marr Construction Company, and under his direction were installed a large number of important plants in the Eastern and Middle States, in Cuba and in Brazil.

Queen's New Bunsen Photometer.—A large standard photometer designed for the measurement of incandescent lamp luminosity has recently been made by Queen & Co., of Philadelphia, for the Standard Lamp Company, of Appleton, Wis. This photometer differs from the large ones previously made in that it has special attachments for holding and testing the lamps which enable the work to be done rapidly as well as accurately. The instrument may be briefly described as follows: Two tables about four feet high (with drawers in them for accessories) support the standard bar, which is made of brass, 500 centimetres long and graduated in 1,000 equal parts. The left-hand table carries a sensitive candle balance arranged for weighing the candle while in use. A standard Methvin burner is furnished in addition, which gives a uniform gas flame. On the right hand table is a special lampholder which can be rotated so as to present any part of the lamp to the sight box. This holder is extremely convenient, as it is only necessary to insert the lamp in the socket when a test is made, all connections being from below. A sight box on wheels moves along the bar, and curtains are provided to shut out all light except from the standard and the lamp under test.

Slate for Electrical Purposes.—T. J. Murphy, of 96 Columbus avenue, New York City, is making a specialty of preparing Vermont slate for use in electrical installations and for this purpose has a finishing shop at Fair Haven, Vt. He is now constructing a slate switchboard 13 feet long and 73 inches high made in six pieces for the Electrical Construction and Supply Company, of this city, to be used in a plant now in process of erection for the H. B. Claflin Company's building. Elsewhere in our columns Mr. Murphy has pointed out from the commercial standpoint the advantages of Vermont slate for electrical purposes, and in order that those not familiar with the finish, quality and working properties of slate may be informed, Mr. Murphy will furnish to any of our readers who are interested a sample of both plain and marbleized slate and

should any special finish be desired, he will furnish a sample of flowed black, polished black, dull black, flowed marbleized, polished marbleized and plain slate, the six pieces of any size under 12 inches square and 1 inch thick for $1.50, or 50 cents for any one piece. As the slate is used for transformers, fuses, resistance coils, bases for knife switches, rheostat heads, terminal boards, washers, etc., it will be seen that different finishes are very desirable. Mr. Murphy reports very satisfactory sales, and judging from the number of inquiries and the interest taken in his samples the prospects for a very wide field of application of this material are excellent.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

The Easton Electric Company, main office 45 Broadway, New York City; factory, Brooklyn, N. Y., is the manufacturer of the celebrated Easton arc dynamos; new Universal arc lamps for arc and incandescent circuits, adapted to any dynamo; Easton incandescent dynamos, generators, motors, etc. Plants are installed at Rockland, Me.; Elmira, N. Y.; Lynchburg, Va.; Newark, N. J.; Brooklyn, N. Y.; Denver, Colo.; Chicago, Ill.; Milwaukee, Wis.; Burlington, Ia.; Reading, Pa.; Birmingham, Ala.; Milledgeville, Ga.; Washington, D. C.; Coney Island, N. Y.; Whitehall, N. Y.; Eureka, Kan.; Lee, Mass., and Lakeland, Fla. Testimonials and indorsements of the highest character furnished on application. This company is now prepared to enter into an arrangement of a favorable character with a reliable and satisfactory concern who will undertake the exclusive sale of the entire output of the factory for the United States. Correspondence invited.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED JUNE 16, 1891.

454,018. Electric Signal for Mine Shafts; Fred W. Bacorn, of Marysville, Mont. Application filed Sept. 2, 1890. The combination with cage chairs and a lever to operate and bars to connect said lever and chairs, and a fixed electric contact point, of an adjustable electric contact point attached to and actuated by one of said connecting bars, an electric circuit and signaling devices therein.

454,020. Electric-Railway Car; Edward M. Bentley, of New York. Application filed March 26, 1887. The combination of the truck frame mounted upon the axles independently of the car springs, the electric motor supported beneath the car body on the frame, the countershaft having substantially rigid bearings on the frame with the motor and driven by the latter, and the car axles having substantially rigid bearings with the countershaft and driven therefrom by means of a connecting rod.

454,021. Electric-Motor Car; Edward M. Bentley, of New York. Application filed June 13, 1888. An electric motor journaled on an axle of a truck which it drives, and arranged in an upright position, with its pole-pieces and armature uppermost as described.

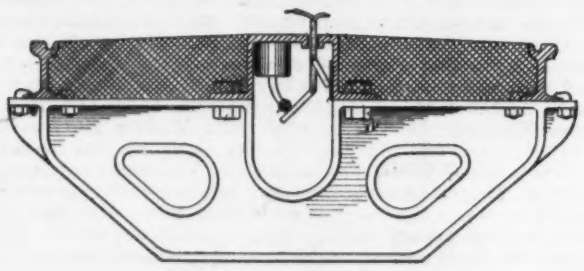
454,022. Conduit for Electric Railways; Edward M. Bentley, of New York. Application filed Sept. 8, 1888. The combination, in a conduit for an electric railway, of a slot-rail having a series of supporting yokes, and an exterior box placed outside of the slot-rail at a point between two adjacent yokes, said box opening into the conduit and containing a support for the supply conductor.

454,023. Electric Railway; Francis O. Blackwell, of Boston, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Oct. 22, 1890. An electric railway having a supply conductor and rail return, and an accessible bare supplementary conductor connected electrically with the rails for increasing the conductivity of the return branch of the circuit, and in contact with which the traveling motor also is maintained. (See illustration.)

454,024. Electric Motor; Harry H. Blades, of Detroit, Mich. Application filed May 11, 1889. In a dynamo-electric machine, the combination, with the armature rings, of an internal spider or hub frame engaging therewith, and rings cast on the spider arms and forming an annular support for balancing weights for the armature.

454,031. Electric Switch; Horace T. Clark, of Bridgeport, Conn. Application filed April 15, 1891. In an electric switch, the combination, with suitable terminals, of a circuit closing bar pivoted at its heel end, an L-shaped rocking lever having pivoted thereto a swinging actuator, and a spring adapted to engage and move said actuator.

454,038. Incandescent Electric Lamp Controller; John J. Fanning, of Chicago, Ill., Assignor of one-half to John Bairstow.



NO. 454,023.—ELECTRIC RAILWAY.

of same place. Application filed Nov. 4, 1890. The combination, with a group of incandescent lamps, of a rheostat consisting of wire wound upon the cylinder of insulating material, the different convolutions being separated from one another and the wire forming the lower portion or portions of the coil being of less area in cross-section than the wire forming the upper portion of the coil, vertical rods or guides with which one end of the circuit is electrically connected and the brush mounted thereon, said brush upon its inner surface conforming to the shape of the cylinder and being constantly pressed against the same by spring-pressure, with means for moving the brush up and down to gradually introduce the resistance of the rheostat into the circuit.

454,057. Galvanic Battery; William Macmillan, of New York. Application filed Oct. 17, 1890. A porous cell for galvanic batteries, consisting of a perforated cup of a stiff fluid-resisting paper.

454,060. Insulated Electric Conductors; Edwin D. McCracken, of Alpine, N. J., Assignor to the Norwich Insulated Wire Company, of New York. Application filed March 5, 1891. An electrical conductor having wound thereon an insulating ribbon of paper folded longitudinally.

454,087. Electric Locked Switch; Francis Teague, of London, County of Middlesex, England, Assignor to John Abbott Iliffe, of same place. Application filed Dec. 15, 1890. A locked electric switch, having the combination of a spindle, an actuating handle and releasing arm, all turning together, and a brush and locking arm placed loosely upon said spindle and turning therewith when making contact, a locking spring engaging with a detent, a turning spring and stop, placed remotely from the curved front of the releasing arm to arrest the brush engaged therewith midway between contacts. (See illustration.)

454,090. Transformer; Elihu Thomson, of Swampscott, Mass. Application filed Oct. 11, 1890. The invention consists of a rectangular sectional core having two of its sides covered by the primary and secondary coils wound thereon, and its other side flush with the ends of the coils of the closed iron frames of magnetic material surrounding the cores and coils and completing the magnetic circuit.

454,091. Secondary Battery; Donato Tomasi, of Paris, and Charles Theryc, of Marseilles, France. Application filed Nov. 10, 1890. An electrode made in tubular form and provided at one of its ends with an insulated plate or disc and a suspending and conducting rod secured at one end to said plate.

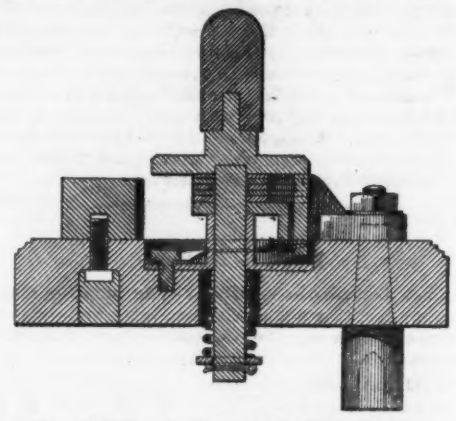
454,095. Controlling Mechanism for Elevators; Wm. O. Wakefield, of Lynn, Mass., Assignor to the Thomson-Houston Electric Co., of Connecticut. Application filed Aug. 6, 1890. The combination of an electric motor with a regulator therefor, a plunger working within a cylinder and connected with the regulator, and a valve mechanism under the control of the attendant for controlling the movement of the plunger.

454,138. Bi-Telephone; Ernest Jules Pierrie Mercadier, of Paris, France. Application filed Feb. 27, 1891. A bi-telephone, having two separate tubular casings, each screw-threaded on its outside, and having screwed thereon a cap at each end, one of said caps having a central perforation screw threaded for the reception of a perforated nipple, one of said casings being mounted by means of a screw-threaded collar on either end of a resilient yoke, serving to press said nipples into the ears of the user to support the apparatus.

454,155. Subway for Electric Wires; William Readman, of Toronto, Can., Assignor to John Culmer Hurst, of same place. Application filed July 26, 1890. In a subway for electric wires, the combination of a casing having one of its side pieces cut away at its upper end to form a seat and provided at regular intervals with openings, a series of longitudinal tubes within said casing for the reception of the wires, a removable side piece provided with an inwardly and upwardly extending flange, and a cover for the opening provided with depending flanges adapted to overlap the flanges of the casing and removable side pieces.

454,177. Conduit for Underground or Subway Electric Systems; John J. Miller, of Pittsburgh, Pa. Application filed Feb. 14, 1891. A conduit or subway having a guard-rail and depending hangers arranged between the said rail and the adjacent side of the conduit and terminating above the lower edge of the rail and having a trolley wire secured to their lower ends and provided above the same with bell-shaped drip flanges or guards.

454,178. Motor Car for Underground Electric Systems; John J. Miller, of Pittsburgh, Pa. Application filed Feb. 14, 1891. The combination, with a laterally movable slide, of the



NO. 454,087.—ELECTRIC LOCKED SWITCH.

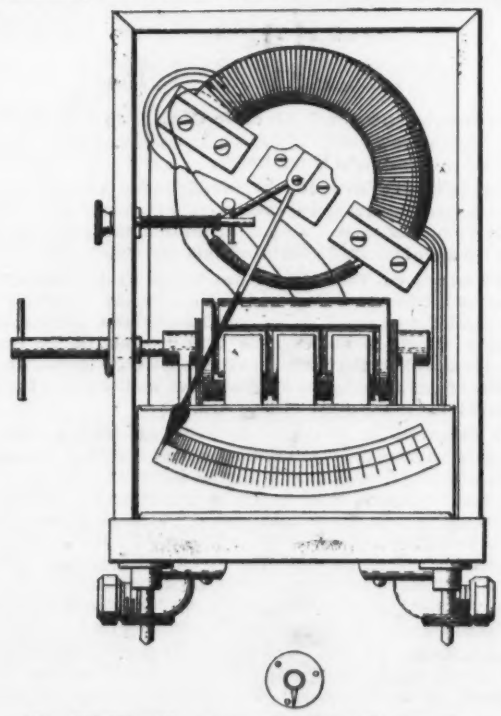
trolley arm mounted in said slide and provided with a flat guide-plate to operate in the conduit slot.

454,181. Connector for Electric Wires; Edmund L. Nash, Geo. G. Stout, and Jesse R. Davis, of Parkersburg, W. Va. Application filed Jan. 20, 1891. A connector for electric circuits, consisting of a metallic tube having screw threaded apertures near its end, a covering of non-conducting material surrounding the tube and provided with apertures coincident with and of greater area than the aforesaid apertures, and a thumbscrew comprising a metal screw portion and an insulated thumb portion, the screw portion working through the screw-threaded aperture of the tube, and the shoulder on the insulated portion fitting into the aperture of the non-conducting covering.

454,184. Electric Head-Light; Richard Pattison and Dennis G. Desmond, of Boston, Mass. Application filed Dec. 9, 1890. A lantern for street car head-lights, comprising a body provided with a reflector and having a rotatable transparent front bearing signs indicating the car-route, and a transparent plate or flange on said body overlapping said front and normally concealing determined portions of said signs.

454,187. Secondary Battery; John S. Sellon, of London, England, Assignor by mesne assignments to the Accumulator Company, of New Jersey. Application filed April 26, 1887. In a secondary battery a plate or support containing an alloy of two metals and an amalgam thereof.

454,207. Electric Resistance Box; Rudolph Eickemeyer, Jr., of Yonkers, N. Y. Application filed Feb. 16, 1891. The combination of a set of resistance coils in two parallel rows, a rigid substantially flat metallic frame and insulating bars in said



NO. 454,270.—ELECTRIC CURRENT INDICATOR.

frame composed of refractory non-combustible material and maintaining the rows of coils and the coils in each row in a properly separated condition and thoroughly insulated from the metallic frame.

454,226. Wall Fixture for Electrical Conductors; Oscar H. Pieper and Frank Milton Watson, of San José, Cal. Application filed Nov. 5, 1890. A wall fixture for electrical conductors, consisting of the tube adapted to receive the conducting wires, having its outside adapted to be fixed into the studding or woodwork within the wall, and an exterior collar fitted to said tube and adapted to receive the cap containing the push button.

454,245. Signal-Indicating Apparatus; Jacob Oscar Ziegler, of Boston, Mass. Application filed Nov. 28, 1890. The invention consists in the combination, with a non-magnetic base consisting of a ring provided with a cross-bar, of an electromagnet having the pole pieces secured to the said base, and an armature pivoted to the cross-bar between said pole-pieces and having the extended arm, a signal indicating device attached to one end of the armature, and a counter balance secured to the other end of the armature.

454,253. Electric-Arc Lamp; Powhatan Clarke, of Baltimore, Md., Assignor of one-half to Frederick H. Smith, of same place. Application filed Feb. 13, 1890. In an electric lamp, two standards furnishing supports for the carbons, two levers suitably pivoted and having a reciprocating movement and provided with means for impelling the carbons toward and away from each other, a spring connecting the levers, whose tension is exerted to approach the levers toward each other, and thereby impel the carbons, a conductor also connecting the arms of the levers, which when heated and expanded allows the spring to act to approach the carbons, and which when cooled and contracted operates in opposition to the spring to separate the carbons, in combination with means controlled by the resistance between the points of the carbons for shunting a greater or smaller current of electricity through the conductor, whereby the latter is cooled or heated.

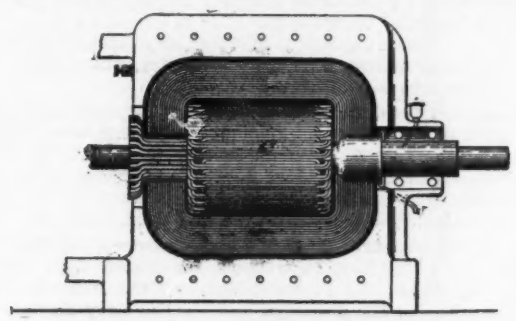
454,262. Incandescent Lamp Filament; Thos. A. Edison, of Llewellyn Park, N. J. Application filed Oct. 27, 1886. Carbon filaments for the incandescent conductors of electric lamps formed from the hard central portions of the roots of plants.

454,270. Electric Current Indicator; Albert B. Herrick, of New York. Application filed Oct. 16, 1890. In a current indicator, a solenoid composed of several coils, a commutator to which said coils are connected for joining the coils in series or in other relation at will, an indicating device controlled by the coil, and a scale marked in sections, the divisions of each section indicating one-half the number of units indicated by a like division on the following section. (See illustration.)

454,275. Tubular Electric Conduit; Edward H. Johnston, of New York. Application filed Sept 15, 1890. A compound tube for electrical purposes, comprising two or more series of lengths of tubing of insulating material of different diameters and of continuous cross section, one series of tubing being slipped within the series next larger in diameter and breaking joints therewith, and a cementing substance between each series of tubing, also of insulating material.

454,294. Electric Arc Lamp; Sam. W. Rushmore, of Brooklyn, N. Y. Application filed Dec. 10, 1890. An arc lamp having carbons and means for controlling the same to establish an arc, said means consisting of a yielding follower upon one of said carbons, but normally held from movement away from the arc, a fixed coil or magnet, an armature for said coil, and a connection between the armature and movable carbon, whereby when the coil is energized the yielding follower is compressed and the carbon is raised.

454,295. Electric Arc Lamp; Sam. W. Rushmore, of Brooklyn, N. Y. Application filed Feb. 16, 1891. A feeding device for arc-lamp carbons, consisting of a swinging or reciprocating frame moved in one direction by a magnet to establish the arc and moved in the opposite direction by the operation of a



NO. 454,336.—DYNAMO ELECTRIC MACHINE.

shunt magnet or coil, and a clutch consisting of two rollers carried by the frame, one of said rollers being movable toward and from the carbon.

454,313. Electric Apparatus for Treating Deafness; Geo. F. Webb, of Jefferson, O. Application filed April 21, 1891. An apparatus for treating deafness, comprising a battery, a belt, an electrode supported on the belt and contacting with a person, an electrode shaped to fit the ear, and connections between electrodes and the battery.

454,336. Dynamo Electric Machine; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed June 15, 1888. In a dynamo electric machine having a cylindrical armature an exciting helix or helices for directly polarizing said armature and a surrounding magnetic shell or casing consisting of a main central section and cheek pieces hollowed to correspond to the cylindrical form of said armature and bolted to the sides of said central section. (See illustration.)

454,338. Electric Telegraphic Apparatus; Sam. Van Buren, of Brooklyn, N. Y. Application filed Jan. 12, 1891. A polar telegraphic instrument consisting of a pair of main-line poles having oppositely disposed core poles at each end of said coils, in combination with a pivoted magnetic core carrying a pair of magnetic contacting arms located between the opposite poles of said main-line magnets, said pivoted core being permanently magnetized by a local coil included in a local battery circuit.

454,344. Electric Block System for Railways; Aug. H. R. Guiley, of South Easton, Pa., Assignor by direct and mesne assignments of two-thirds to Wilson B. Solliday, of same place, and Elijah B. Cornell, of Philadelphia. Application filed Feb. 11, 1890. In an electrical block system for railways, the combination with a pendant contact lever carried by the locomotive of contact pieces provided with two flanged plates insulated from each other, and placed diagonally with reference to the track rails, and adapted to be engaged by the contact lever of the locomotive.

454,430. Method of Making Binding Posts; Edwin T. Greenfield, of New York, Assignor to the Interior Conduit and Insulation Company, of same place. Application filed Dec. 16, 1890. The method of making connecting and supporting block for electrical purposes, consisting in forming a block of insulating material with recesses conforming in shape and position to the terminals to be supported by said block, and then filling said recesses with melted metal and allowing the same to harden and to remain therein.

454,437. Current-Collecting Device; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Dec. 18, 1889. A collector arm for an electrically propelled vehicle formed of a tube of gradually decreasing diameter and provided with an aperture throughout its length, combined with a grooved contact device at its smaller end and a socket piece or holder at its larger end.

454,443. Electric Arc Lamp; John E. McAuley, of Chicago, Ill., Assignor of one-half to Thos. F. Vaughn, of same place. Application filed April 21, 1890. The combination with positive and negative wires of a magnet connected to the positive wire and having a spring-pressed armature, an arm connected with the negative wire, a pin in the armature, and a pivoted lever for forcing the pin in contact with the arm, and the armature in contact with the magnet, thereby shunting the current.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

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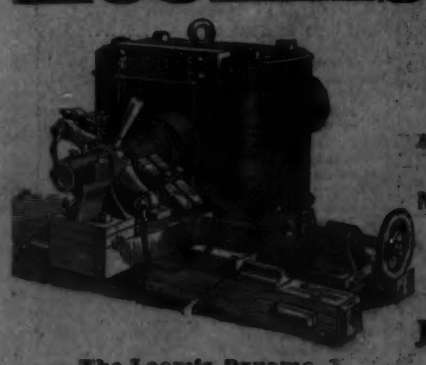

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Ritchie & Sons, E. S.
Wing Co., L. J.

Feed-Water Heaters
Baragwanath & Sons, Wm.
Goubert Mfg. Co.
Kelly & Son, Benj. F.
Stewart Heater Co.
Stilwell & Bierce Mfg. Co.
Webster & Co., Warren.

Fibre (see Rubber).
Delaware Hard Fibre Co.
Kartavert Mfg. Co.
Laminar Fibre Goods Co.
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Fixtures for Electric Lighting.
Edison General Electric Co.
Horn, Brannen & Forsyth Mfg. Co.

Forgings, Drop.
Billings & Spencer Co.
Williams & Co., J. H.

Friction Cones.
Evans Friction Cone Co.

Fuse Wire.
Consolidated Fruit Jar Co.

Gas Engines.
Otto Gas Engine Works

Gas Lighting Apparatus, Electric.
Bogart, A. L.
Hinds, Chas. H.
Smith, A. T.

Gasoline Furnaces.
Haines, Jones & Cadbury Co.

Glass Tube Cutters.
Hunt & Connell, Ltd.

Globes, Shades, etc.
Gillinder & Sons.
Phœnix Glass Co.
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Gongs.
Wilmot & Hobbs Mfg. Co.

Hydraulic Presses.
Watson & Stillman.

Instruction.
Purdue University.
Rose Polytechnic Inst.
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Instruments, Testing & Recording.
Hartmann & Braun.
Kidder Mfg. Co., The Jerome.
Marshall, Wm.
Nassau Electrical Co.
Standard Thermometer Co.
Queen & Co., James W.
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Insulators.
Brookfield, Wm. (Glass)
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Insurance.
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Lamps, Arc, for Incandes. Circuits
Electric Construction & Supply Co.
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Alexander, Barney & Chapin.
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Columbia Incandescent Lamp Co.
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Steele & Johnson Mfg. Co.

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Colwell Lead Co.

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Machinery, Tools, Lathes, etc.
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Betts Machine Co.
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Gardam & Son, Wm.
Garvin Machine Co.
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Norton & Jones Mach. Tool Wks.
Prentiss Tool & Supply Co.
Sebastian-May Co.
Shepard, H. L.
Sigourney Tool Co.

Magneto Bells.
Viaduct Mfg. Co.

Mast Arms.
Star Iron Tower Co.

Metal Spinning.
Remhof, A.

Mica.
Bowers Bros.
Munsell & Co., Eugene.
Schoonmaker, A. O.

Model and Experimental Work.
Colburn Elec. Mfg. Co.
Consolidated Fruit Jar Co.
Greeley & Co., The E. S.
Hoenack, Paul.

Motors, Electric.
Bain, Force.
Barrlett Electric Co.
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Johnson, Russell.

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Devoe & Co., F. W.
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Carr Metal Co.
Davidson, J. T.
Edes, E. L.
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Alexander, Barney & Chapin.
Baxter, H E & C.
Consolidated Elec. Mfg. Co.
Cutter, Geo.
Edwards & Co.
Electric Construction & Supply Co.
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Greeley & Co., The E. S.
Holtzer Cabot Elec. Co.
Ill. Elec. Material Co.
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National Electric Co., Ltd.
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Hunt Machine Co., Rodney.
Leffel & Co. James
Leffel Water-Wheel & Engine Co.
Stilwell & Bierce Mfg. Co.

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Vulcabeston.
Johns Mfg. Co., H. W

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Am. Circular Loom Co.
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Electrical Supply Co.
Globe Electric Cordage Works.
Habirshaw, Wm. M.
Holmes, Booth & Haydens.
International Okonite Co.
Moore, A. F.
N. Y. Insulated Wire Co.
Prescott, Geo. B.
Roebling's Sons Co., John A.
Simplex Electrical Co.
Standard Underground Cable Co.
Tatham & Bros.
Western Electric Co.

Woodwork (Electrical).
Johnson, Russell.
Union Hardware Co

Alphabetical Index to Advertisers.

Accumulator Co., The xxxiii
Alexander, Barney & Chapin i
Amer. Bell Telephone Co xxix
Amer. Circular Loom Co ..... —
Am. District Steam Co xii
Amer. Electric Elevator Co xxx
Amer. Electrical Works iii
Anderson, Albert & J. M xxii
Appleton, T xx
Argand Grate Bar Wks ..... —
Armington & Sims Engine Co xxxiv
Atlantic Covering Co ..... —
Auto. Time Stamp & Reg. Co xxvii
Automatic Switch Co xxvii
B. & S. Electric Equipment Co xxxii
Babcock & Wilcox Co xxxiv
Bain, Force xxii
Baker & Co iii
Ball & Wood Co., The xxxi
Ball Engine Co xxxi
Baragwanath & Son, Wm xix
Barnes Co., W. F. & John xxix
Barrlett Electric Co xxvi
Baxter, H. E. & C xii
Baxter Elec. Motor Co iv
Benham & Schindel xviii
Berlin Iron Bridge Co xxvii
Bernstein Electric Co ..... —
Betts Machine Co ..... —
Billings & Spencer Co ..... —
Bishop Gutta Percha Co ..... —
Bogart, A. L i
Borden & Selleck Co xx
Boston Bridge Works ..... —
Boughen Engineering Co xxx
Bowers Bros xxii
Brill Co., J. G ..... —
Brookfield, William xxvii
Brush Electric Co vii
Buckeye Electric Co xxviii
Bunnell & Co., J. H ..... —
Bush Co ..... —
Burlington Route xx
Butler Hard Rubber Co xxviii
C. & C. Electric Motor Co ..... viii & xi
Cameron Stm. Pump Wks. A. S xxxii
Card Elec. Motor and Dynamo Co. ..... —
Carr Metal Co ..... —
Cary, Alanson ..... —
Chalmers-Spence Co xxx
Chandler & Taylor Co ..... —
Chase, M. C ..... —
Claflin & Kimball xviii
Clark Electric Co xxxii
Clay, Pepper & Register xix
Colburn Elec. Mfg. Co xxviii
Columbia Incandescent Lamp Co. xiv
Colwell Lead Co xxix
Connecticut Motor Co ..... —
Conover Mfg. Co xxx
Cons. Electric Mfg. Co ..... —
Cons. Electric Storage Co vii
Consolidated Fruit Jar Co iv
Cons. Temp. Controlling Co xxxi
Cooke & Co xx
Cooney, P. J ..... —
Copenhagen Electric Alarm Co xxxii
Cornell Electrical Eng. Co xvi
Crane, W. E xxix
Crocker-Wheeler Motor Co xxvi
Curtis Regulator Co ..... —
Cutter, Geo xix
Davidson, J. T xix
Davidson, M. T xxx
Dean Bros. Steam Pump Works xxx
Delaware Hard Fibre Co iii
Devoe & Co., F. W ..... —
Dixon Crucible Co., Joseph iv
Eastern Electric Cable Co xix
Eastman Co., The xxv
Easton Elec. Co xxiii
Eckert Elec. Mfg. Co xvi
Edes, E. L xxiv
Edison General Electric Co xiv
Edwards & Co ..... —
Eklektik Equipment Co iv
Electric Construc. & Supply Co vi
Electric Engineer. & Supply Co xxix
Electric Merchandise Co vii
Electric Ry. Specialty Co xxv
Electrical Construction Co xix
Electrical Engineering Co xix
Elektron Mfg. Co., The x
Emerson Elec. Mfg. Co xxi
Emmet Bros. & Griswold xix
Empire China Works iii
Empire City Electric Co xviii
Endicott & Macomber xviii
Equitable Engin. & Cons. Co xix
Esterbrook Steel Pen Co xxiii
Eureka Electric Co i
Eureka Tempered Copper Co xxvii
Evans Friction Cone Co xxi
Excelsior Elec. Co vi
Falls Rivet & Machine Co xvi
Fidelity Carbon Mfg. Co xxvi
Fitchburg Steam Engine Co ..... —
Foote Regulator Co., T. M ..... —
Ford & Washburn Electric Co xxxii
Forest City Electric Works ..... —
Ft. Wayne Electric Co xxvii
Frink, I. P xxiv
Frisbie Co., D iv
Gardam & Son, Wm xix
Garvin Machine Co iii
Gethins Elec'l Mfg. Co x
Gibson Electric Co xxxiii
Gillinder & Sons xxiii
Globe Carbon Co xxvi
Globe Electric Cordage Works xxix
Goodrich Co., B. F xvii
Goodrich Hard Rubber Co xvii
Gordon & Co., W. H xxi
Goubert Mfg. Co ..... —
Gould & Eberhardt xxxii
Grant & Co., J. A xxx
Graphite Lubricating Co ..... —
Greeley & Co., The E. S i
Greene, Tweed & Co ..... —
Griffith & Co., W. S xxxiv
Hadley Co ..... —
Haines, Jones & Cadbury Co ..... —
Hanson & Van Winkle Co iii
Harrisburg Car Mfg. Co. (F. & M. Dept.) xxxi
Harris Oil Co., A. W xix
Harrison Safety Boiler Works ..... —
Hartmann & Braun xxii
Heine Safety Boiler Co ..... —
Heisler Electric Light Co xxii
Hendey Machine Co ..... —
Hill Clutch Works iv
Himmer & Anderson ..... —
Hinds, C. H xxix
Hoenack, Paul iii
Holmes, Booth & Haydens xvii
Holtzer-Cabot Electric Co xvi
Horn, Brannen & Forsyth Mfg. Co., The xxix
Houghton & Co., E. F xxiv
Hunt & Connell, Ltd xxiv
Hunt Engineering Co xxxiii
Hunt, Machine Co., Rodney ..... —
Hunter & Sons, James xxx
Hutton, Henry ..... —
Huyett & Smith Mfg. Co xxi
Illinois Electric Material Co xxxiv
India Rubber & Gutta-Percha Co. ..... —
Interior Conduit & Insulation Co. xxiii
International Okonite Co., The xxviii
Jenkins Brothers i
Jessop & Sons, Ltd., Wm ..... —
Jewell Belting Co ..... —
Johns, Mfg. Co., H. W iv
Johnson, Russell xxiv
Johnston Co., W. J. viii, xxiii, xxiv, xxvi
Jones & Co., Jesse iii
Kartavert Mfg. Co iv
Kelley & Sons, B. F ..... xxx, xxiv, xx
Kendall & Sons, Edward ..... —
Keystone Electric Co ..... —
Kidder Mfg. Co., Jerome xxiv
Laminar Fibre Goods Co vii
Lane & Bodley Co xxx
Lang & Co., J xxix
Law Telephone Co xix
Leclanche Battery Co iii
Leffel & Co., J xxv
Leffel Water Wheel & Engine Co. xii
Lloyd & Paxton, Ltd viii
Locke Brothers xxxiv
Lunkenheimer Brass Mfg. Co ..... —
Magnolia Anti-Friction Metal Co. i
Maine Elec'l Imp. Co iv
Marshall, Wm iii
Massachusetts Elec'l. Eng. Co i
Mason Regulator Co xxxiv
Mass. Mfg. & Elec. Supply Co. xxi
McCollin, T. H xxii
McGowan Co., The John H xxx
McIntire Co., The C iii
McIntosh, Seymour & Co xxxiv
McLeod, Ward & Co xxi
Milliken Bros xvii
Moore, A. F i
Munsell & Co., E iii
Munson Belting Co., Chas vii
Murray & Co., J. J ..... —
Murray Co., The Thos i
Nassau Electrical Co xix
National Carbon Co xxii
National Electric Co xxii
National Electric Co., Ltd ..... —
National Electric Mfg. Co ix
N. Y. Carbon Works xxxiii
N. Y. Ins. Wire Co ..... i & x
N. Y. & Ohio Co i
N. Y. Safety Steam Power Co. xxxiv
Northwestern Elec. Specialty Co. xiv
Norton & Jones Mach. Tool Wks. iii
Novelty Electric Co xxiv
Nowotny Electric Co xvi
Noye Mfg. Co, John T xxxiii
Osborn & Alexander xxii
Ostrander & Co., W. R xxxiv
Otis Brothers & Co xxxiv
Otto Gas Engine Works xxxi
Page Belting Co ..... —
Paiste, H. T xviii
Paine & Sons, Chas xix
Parmly, Mitchell & Co xxiv
Partrick & Carter v
Pass & Seymour xxiv
Pattison Brothers xix
Payne & Sons, B. W ..... —
Penrhyn Slate Co xxv
Perkins Elec. Switch Mfg. Co xvii
Pettingell-Andrews Co xxiv
Phœnix Glass Co xxxiii
Phœnix Iron Works ..... —
Phosphor Bronze Smelting Co. xxxiii
Pittsburgh Boiler Scale-Res. Co. ..... —
Pittsburgh Reduction Co xix
Platt, Chas. S iv
Pond Engineering Co xxx
Prentiss Tool & Supply Co xx
Prescott, Jr., Geo. B xxxii
Purdue University xxix
Purity Oil Filter Co xii
Queen & Co., Jas. W xix
Reddaway & Co., F xxix
Redding Electric Co v
Remhof, A xxix
Ripley, H. C xxiv
Ritchie & Sons, E. S xvii
Rochester Mach. Tool Wks, Ltd. xxxi
Roebling Sons Co., John A xviii
Rose Elec. Light Supply Co xx
Rose Polytechnic Inst xxii
Russell Electric Co xvi
Ryle & Co., Wm iv
St. Louis Elec'l Supply Co xxvi
Santley Lumber Co xxiv
Sawyer Man Elec. Co xiii
Schawel & Co., Jas xix
Schieren & Co., C. A i
Schoonmaker, A. O xxix
Schuyler Electric Co xxxiii
Scott Electrical Mfg. Co xix
Sebastian-May Co xix
Sessions Foundry Co viii
Shaw & Co., J. Elliott xxii
Shepard, H. L iii
Shipman Engine Co ..... —
Short Electric Ry. Co xx
Shultz Belting Co ..... —
Sieb & Starke ..... —
Sigourney Tool Co xxii
Simplex Electrical Co i
Sioux City Engine Works xxxii
Smith, A. T xxii
Smith & Valle Co xxx
Solar Carbon & Mfg. Co ..... —
Spencer's Sons, I. S xvi
Sperry Elec. Mining Machine Co xviii
Standard Electric Supply Co viii
Standard Electric Time Co ..... —
Standard Paint Co xxxii
Standard Thermometer Co xvi
Standard Und. Cable Co xxxiv
Stanley Elec. Mfg. Co ..... —
Star Electrix Co iv
Star Iron Tower Co ..... —
Stearns Mfg. Co xxxi
Steele & Johnson Mfg. Co v
Stephenson Co., Ltd., John xxvi
Sterling, W. C xxii
Stewart Heater Co ..... —
Stilwell & Bierce Mfg. Co iii
Stratton Separator Co xxix
Tatham & Brothers iii
Taylor & Son xvi
Thill's Sons & Co., F xxiv
Thomas & Sons, R xii
Thomson-Houston Elec. Co v
Toronto Cons. and Elec. Sup. Co. xxvii
Triumph Compound Engine Co. xxxi
Tropical Am. Telephone Co ..... —
Truex & Vail xix
Tucker Elec'l Con. Co i
Tucker & Hall xix
Underwood Mfg. Co ..... —
Union Export and Trading Co ..... —
Union Glass Co xxvi
Union Hardware Co xxix
Union Porcelain Works ..... —
Universal Arc Lamp Co xxi
U. S. Elec. Lighting Co ..... —
U. S. Electric Railways Co xxii
Van Nuis C. S xix
Variety Iron Works Co., The xxx
Viaduct Mfg. Co xxv
Vulcanized Fibre Co iii
Wallace & Sons xxv
Walsh, Owen xxii
Walworth Mfg. Co xxxiii
Watson & Stillman xxxiii
Webster & Co., Warren xxx
Western Electric Co xxxii
Western University of Pa xxxii
Westinghouse El. & Mfg. Co xiii
Westinghouse Machine Co xxxi
Weston Elec'l Instrument Co xviii
Weston & Co., Wm. H xxvi
White Dental Co., S. S xxviii
White & Co., J. G xxxii
Whitmore & Robinson i
Wilkinson, W. H xxxi
Williams Engine Works xxx
Williams & Co., J. H xxxii
Wilmot & Hobbs Mfg. Co xxxiv
Wing Co., L. J xxxiv
Wollensak, J. F xxiv
Woodbridge & Turner Eng. Co xix
Woodhouse & Rawson ..... —
Worthington, H. R xviii
Wright & Starr xxiii
Wunder, Frank A xx
Want and For Sale Ads xx

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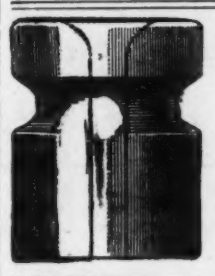

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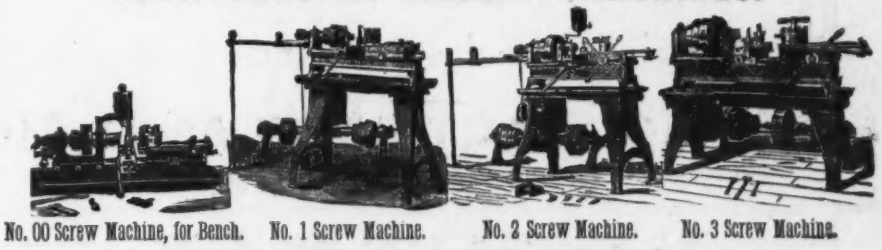

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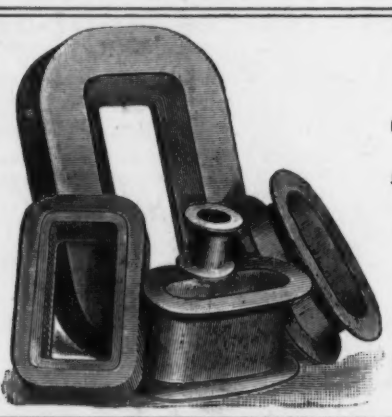

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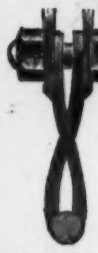

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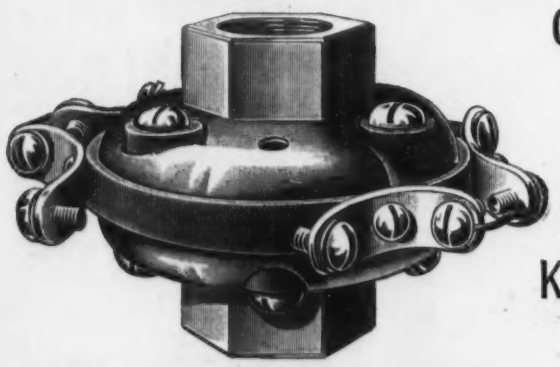

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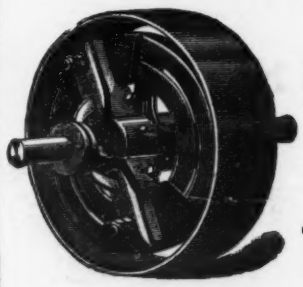

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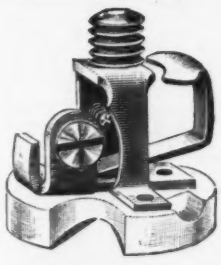

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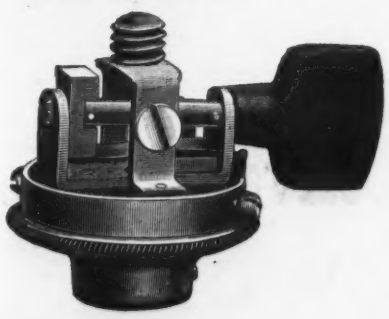

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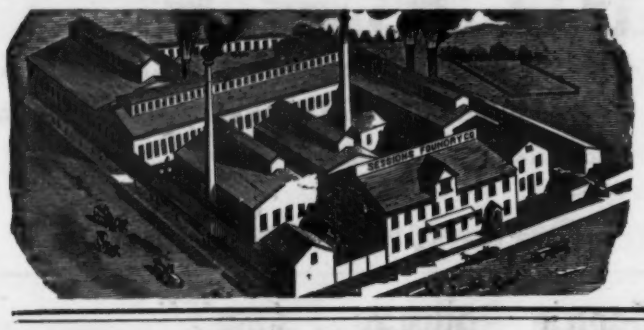

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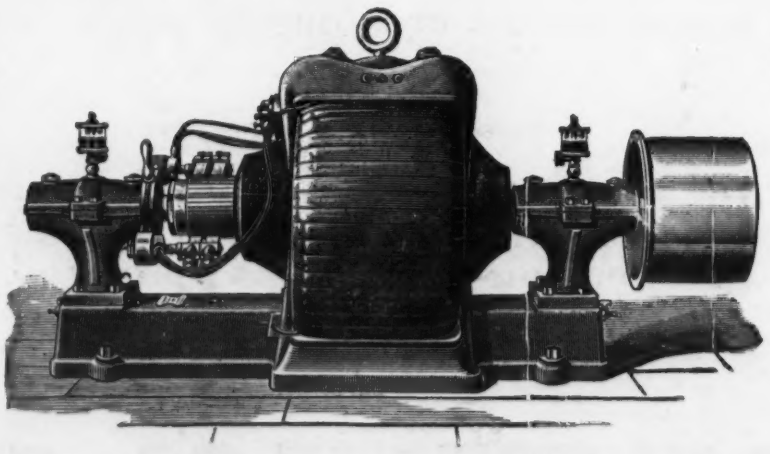

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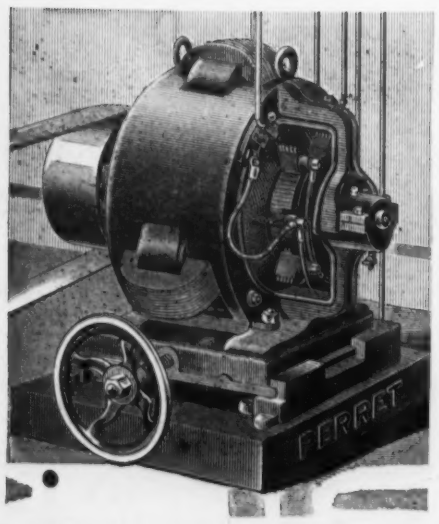

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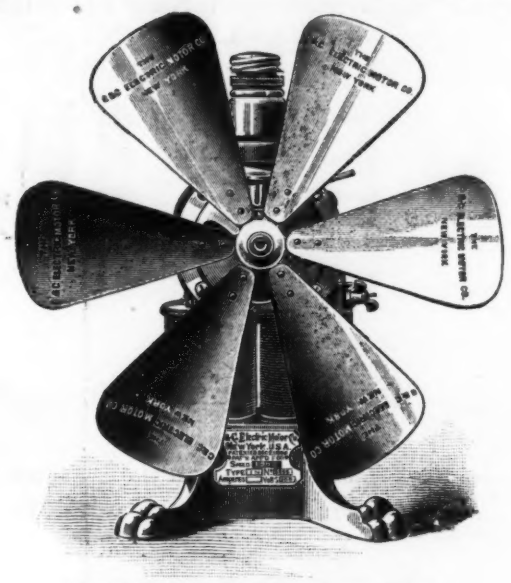

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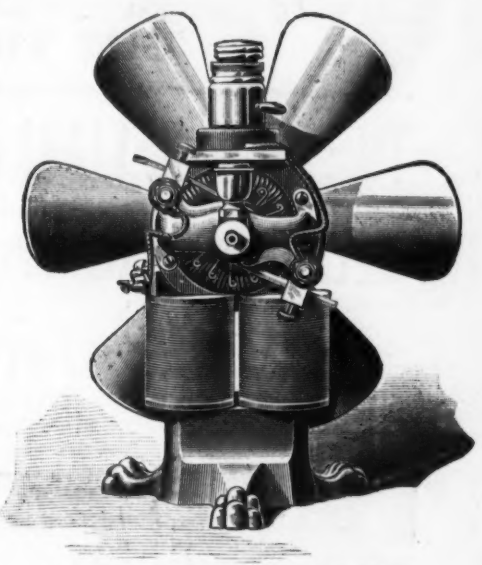

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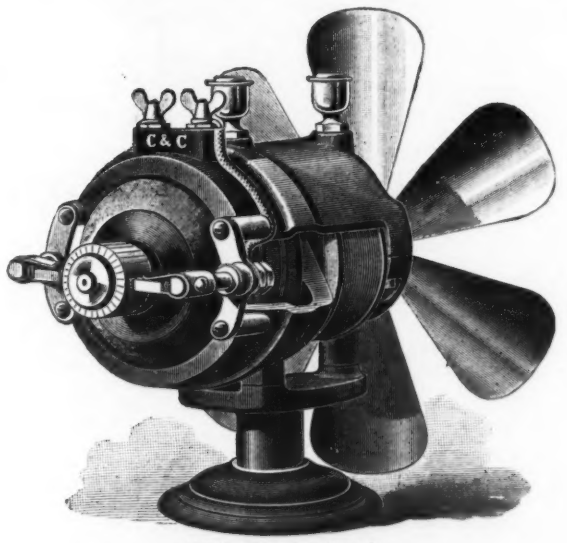

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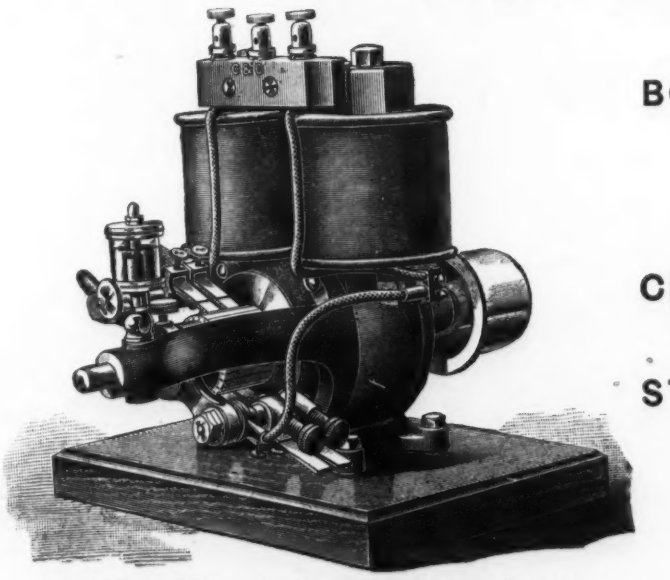

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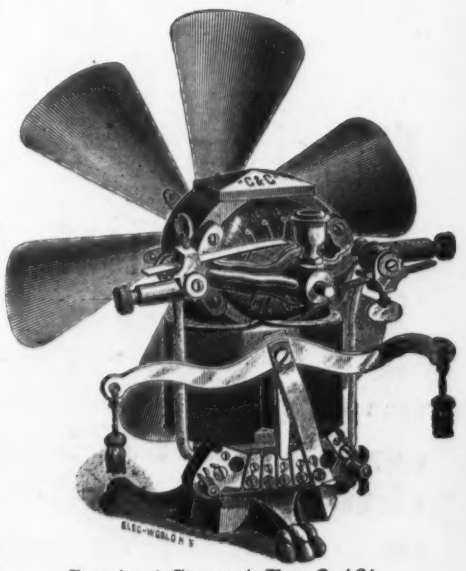

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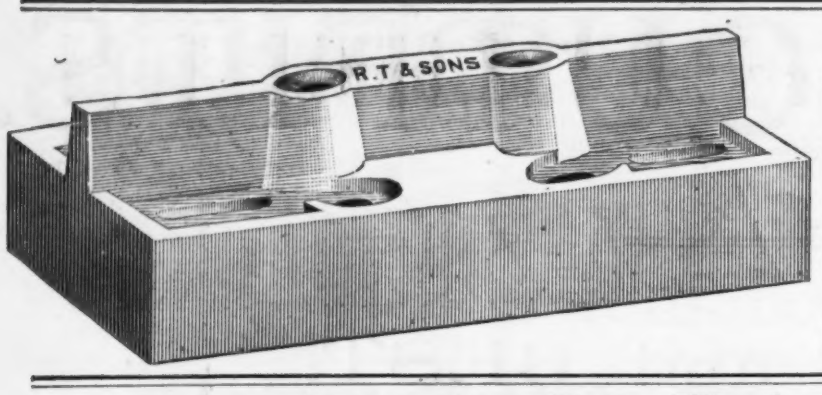

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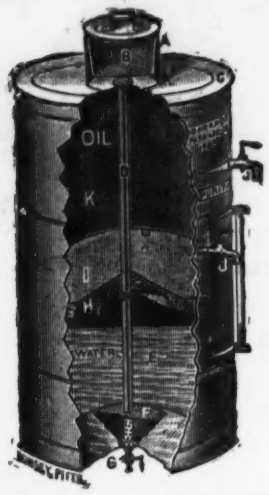

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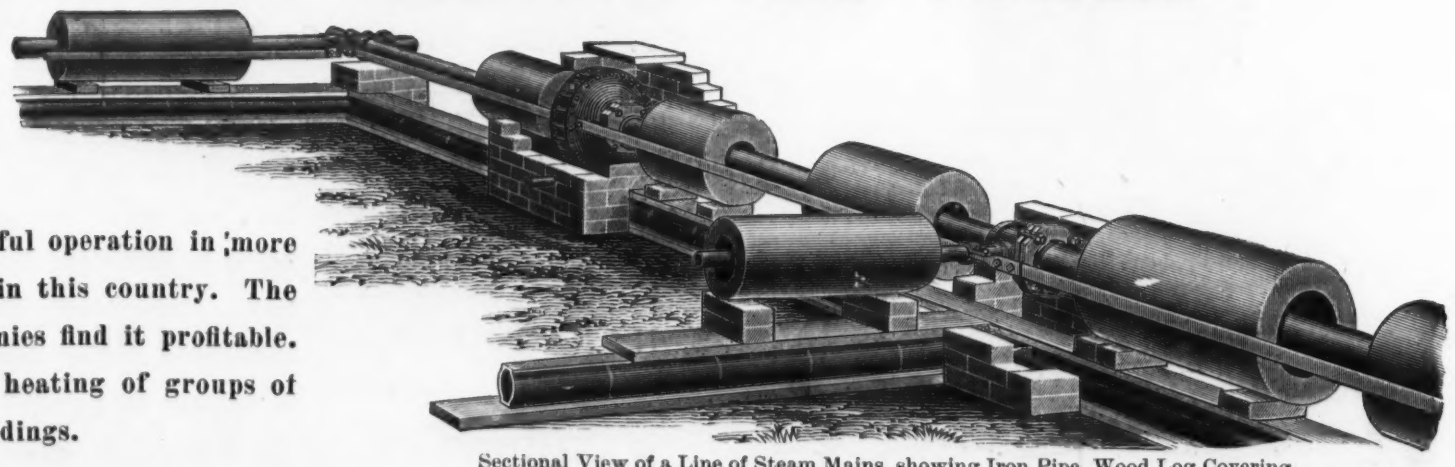

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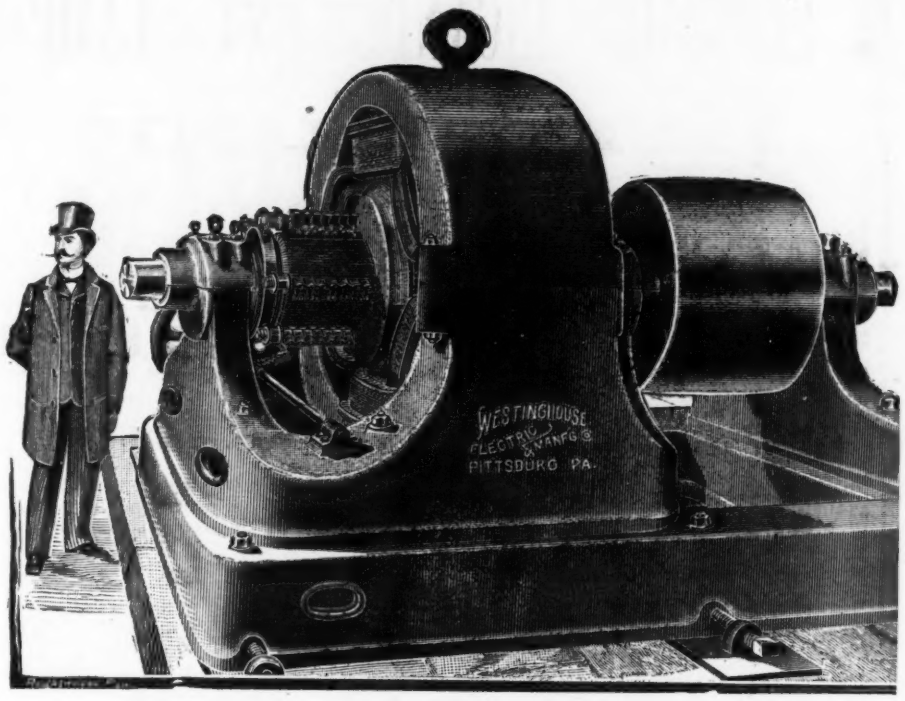

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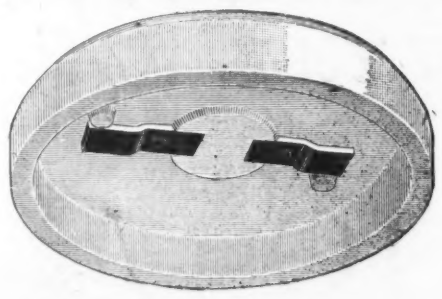

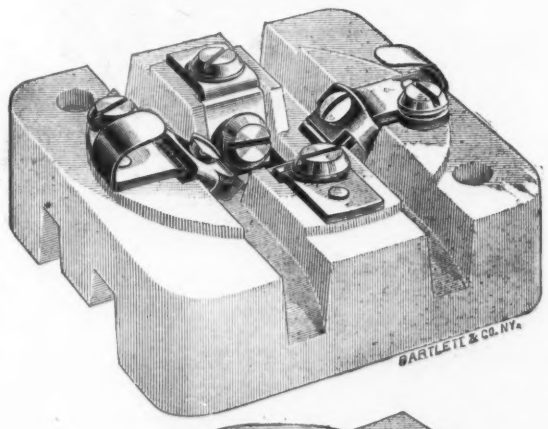

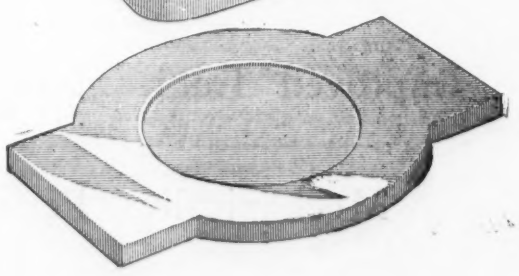

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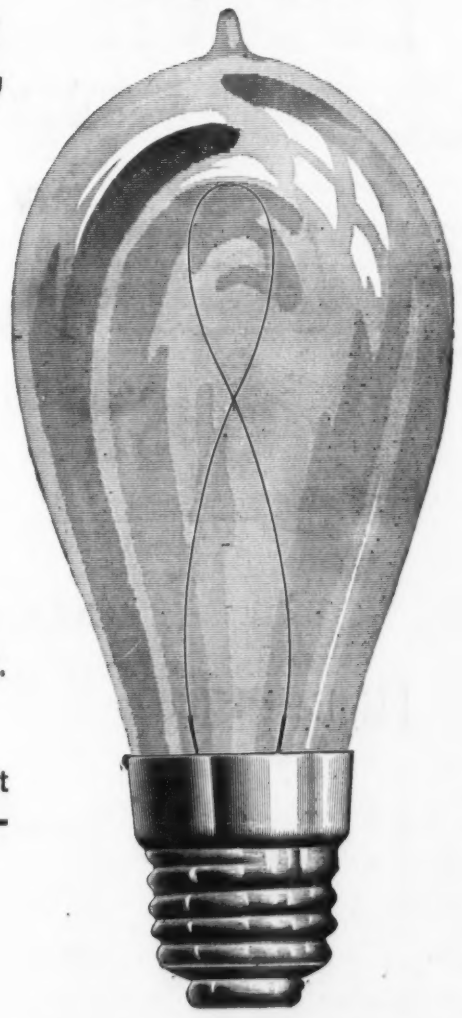

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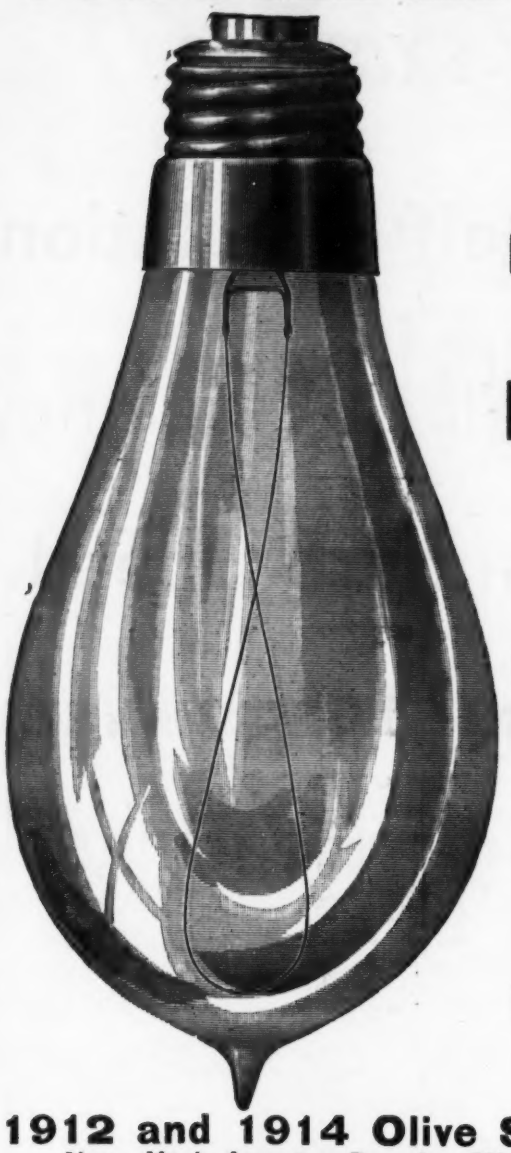

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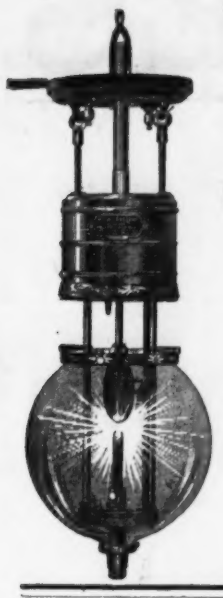

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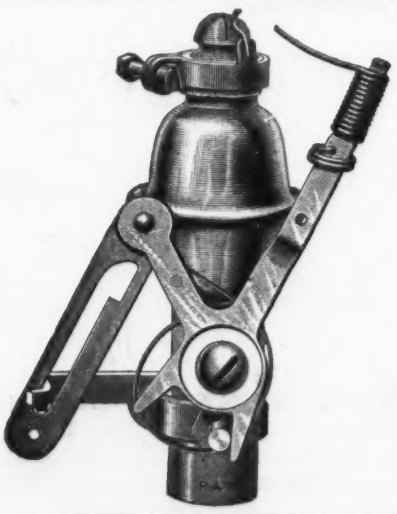

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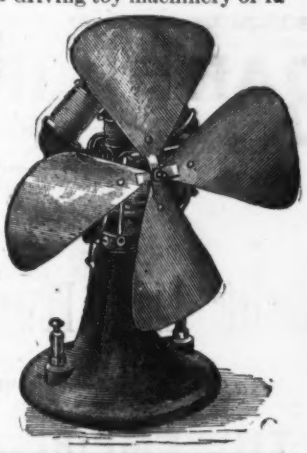

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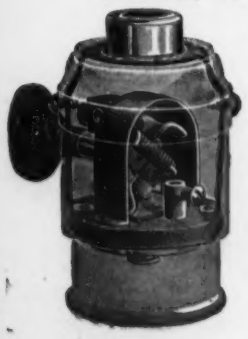

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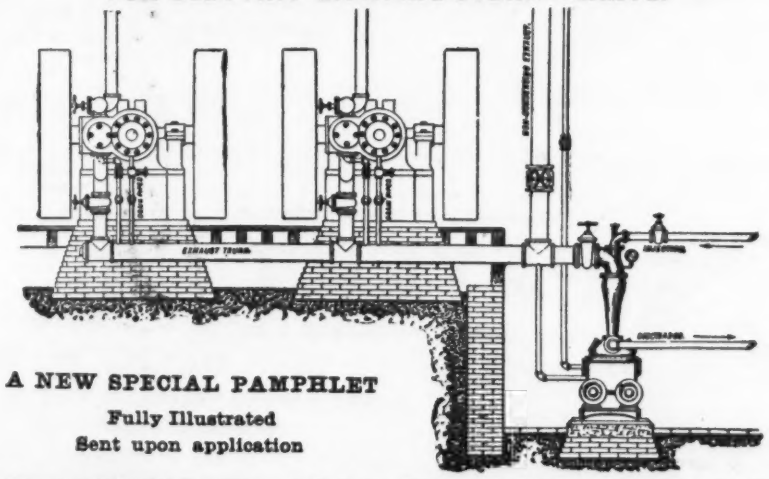

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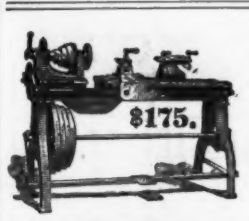

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MY DEAR SIR: Complying with your request for a testimonial letter regarding the Swinging Ball Arrester, we take the greatest pleasure in recommending it in every particular as being one of the best protectors that we have ever come across. Prior to our using it we were annoyed by lightning burning out over 50 lamps at one time, but since using them, about 12 months ago, we have not been troubled in the least.

Yours respectfully,
THE BOONTON E. L. H. & P. Co.,
[Signed] J. J. GREEN, Manager.

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Ammeters and Voltmeters.

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CLARK JOINT GUM should be used for making water-proof joints. This is put up in half-pound boxes, in strips about one foot long and five-eighths inch wide, and when wrapped about a joint and pressed firmly it makes a solid mass.

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SITUATION WANTED—BY ELECTRICAL Engineer; care of central station preferred. Best of references. JAMES A. HARRIS, Ellenville, N. Y.

WANTED—A YOUNG MAN (25) DESIRES A position in some electrical establishment or station to learn the business. Has a pretty fair knowledge of motors, dynamos and electricity in general. Address POSITION, No. 170, THE ELECTRICAL WORLD, New York.

SITUATION WANTED—WIREMAN OF SIX years' experience desires position. Familiar with the principal systems; thorough experience with alternate systems. Best of reference. Address F. B. F., No. 165,
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WANTED—A POSITION WITH AN ELECTRIC light company. Have had three years' experience with T.-H. and Schuyler systems, and three years in machine shops. Also had charge of gas company with electric lights for 12 months. Address J. M. WOOD, Superintendent, Spartanburg, S. C.

WANTED—YOUNG MAN WITH PUSH IN every section to sell the 1891 1-10 h. p. electric motor. Just out. Also the 1891 battery (runs the motor one week without recharging). Better than others at one-half the price. Quick sales. To those who have a few hours to spare, and one interested in electricity, a good opportunity is opened to make money easily. For particulars address O. A. FOSTER, No. 8 Oliver street, Boston, Mass.

WANTED—AN AMERICAN ELECTRICAL Engineer, familiar with all branches of the profession and expert in experimental work, particularly telegraphic and telephonic, is desirous of engaging with parties who have new inventions or systems to develop and introduce. Has had extensive practice in Europe, both with apparatus and with patents. Long experience, best references, modest expectations. Address MULTIPLEX, No. 171,
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RESPONSIBLE POSITION WANTED—A young man having a thorough, practical experience in the construction and repairing of arc lamps (any style) motors, or any electrical instruments; rewinding burnt out armatures, etc.; also thoroughly understands wiring for burglar alarms, call system, electric gas lighting and wiring for electric lights and motors, or to take charge of electric light plant, or motors of an electric railway. Address ELECTRI, No. 158, THE ELECTRICAL WORLD, New York.

WANTED—A MECHANICAL ENGINEER, A young man, now holding a responsible position in a large manufacturing concern, desires to make a change. Experienced in erecting, testing and economical management of steam plants and in modern machine shop practice, also in designing automatic machinery for the economical production of sewing machines, electrical instruments, etc. Have had considerable experience in handling men and in shop management. Can give A1 references. Address A. S. M. E., No. 162,
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EXPERT ELECTRICIAN, DESIRING TO CHANGE his present position, wishes re-engagement as such to some large institution, light and power station, steamboat or railroad company, hotel or theatre, in any part of the United States or Canada. Twelve years' experience in, and thorough knowledge of, all systems of electric lighting, construction and estimating, telephony and telegraphy and the minor branches. Expert care and management of storage batteries a specialty. Perfect French and Spanish. Highest references from present (four years' service) and past employers as to skill and integrity. Address ACCUMULATOR, No. 160,
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W. A. JOHNSTON, Secretary,
Latrobe, Pa.

SEALED PROPOSALS.—NOTICE TO ELECTRIC Light Companies: Sealed proposals for the lighting of the streets of the village of Little Falls by electricity will be received at the trustees' room in said village, until 8 o'clock P. M., June 30, 1891, at which hour the bids will be opened and read, and the contract therefor awarded to the lowest responsible bidder or bidders as soon thereafter as practicable. Each proposal must be accompanied with a certified check for two thousand dollars ($2,000), payable to the order of the president of the village, deposited on condition that the party or parties whose bid is accepted will appear at the office of John D. Beckwith, corporation attorney in said village, with the securities offered by him or them and execute the contract for said work and the bond for the faithful performance of the same within three days from the date of notification of such award, and in case of failure or neglect to do so, he or they will be considered to have abandoned it, and the deposit shall be forfeited to said village as liquidated damages for such failure. The lighting of the streets is to commence on Sept. 1, 1891. Each bidder must state both in figures and in writing the price per light for eighty (80) two thousand (2,000) candle power electric arc lights to be placed at such places within the village limits as the board of trustees shall designate, and the bidder must also specify a price per light at which he will furnish as many more lights as the board of trustees shall from time to time order. Each bidder must designate the system of arc light which he or they propose to furnish; the lights to burn from dusk to daylight every night in the year. The president and board of trustees reserve the right to reject any or all bids.
OLIN W. TIMMERMAN,
Clerk of the Village of Little Falls.
Dated Little Falls, N. Y., June 11, 1891.

THOMAS APPLETON, M. A. S. C. E.
Civil Engineer and Architect.

Designs and superintends construction of electric railways, electric light and power stations, steam and water power plants, machine shops, foundries, etc.
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TREASURY DEPARTMENT, OFFICE OF THE Secretary, Washington, D. C., June 13, 1891. Sealed proposals will be received at this department until 2 o'clock P. M., Monday, June 29, 1891, for furnishing electrical supplies required during the fiscal year ending June 30, 1892, for United States buildings at Philadelphia, Pa.; Cincinnati, O.; Boston, Mass; Pittsburgh, Pa.; Chicago, Ill.; St. Louis, Mo.; Kansas City, Mo.; New Orleans, La.; Baltimore, Md., and Minneapolis, Minn. Instructions to bidders will be furnished upon application. Separate detailed proposals, stating the price per unit of quantity for all supplies incident to the maintenance of the electric light plants operated in United States buildings in the cities above named to be submitted. The department reserves the right to two annual renewals of accepted proposals, and to reject any or all bids or parts of bids, and to waive defects. Proposals must be addressed to the Secretary of the Treasury, Washington, D. C., and marked "Proposals for Electrical Supplies."
CHARLES FOSTER, Secretary.

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The most charming Summer Resorts, of which there are over three hundred choice locations, are to be found in Wisconsin, Iowa, Minnesota, South Dakota and the Peninsula of Michigan, along the lines of the Chicago, Milwaukee & St. Paul Ry. Nearly all are located near lakes which have not been fished out.

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One 30-light Fort Wayne Jenney dynamo, with 23 single lamps (low tension).
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One 13-light Thomson Houston dynamo, with 13 single lamps, 2,000 c. p. One 70-light, 4 ampere, Ball dynamo, no lamps.

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One 250-light Edison Dynamo, 110 volt.
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One Bay State 50 h. p.
Two 7 h. p. vertical Straight Line engines (new).
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1 " 72 in. x 60 in. x 15 ft.
1 " 80 in. x 80 in. x 9 ft., with one head.
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Friction Shapers, 15 in., 22 in., 32 in.
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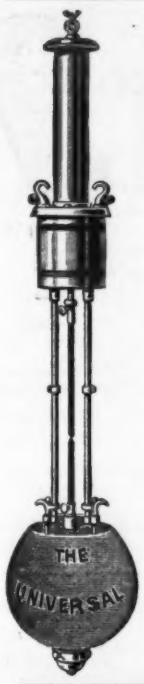

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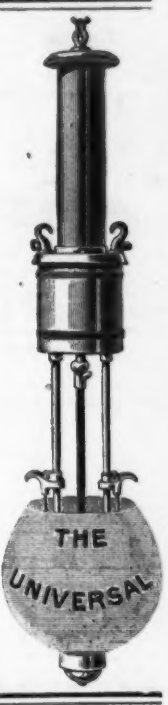

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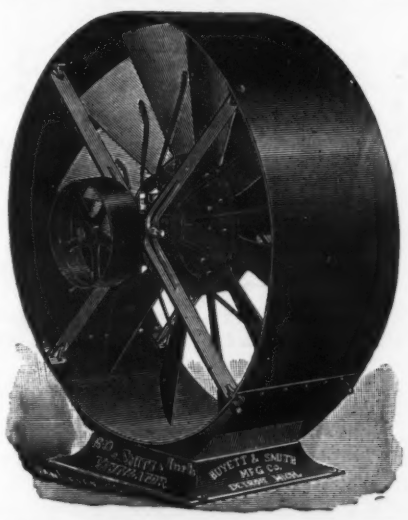

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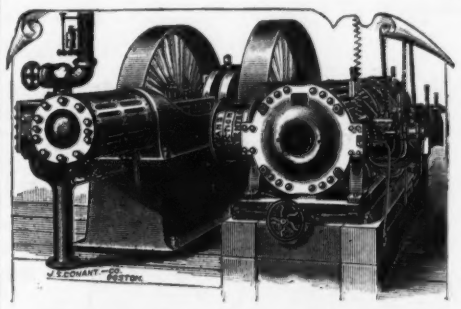

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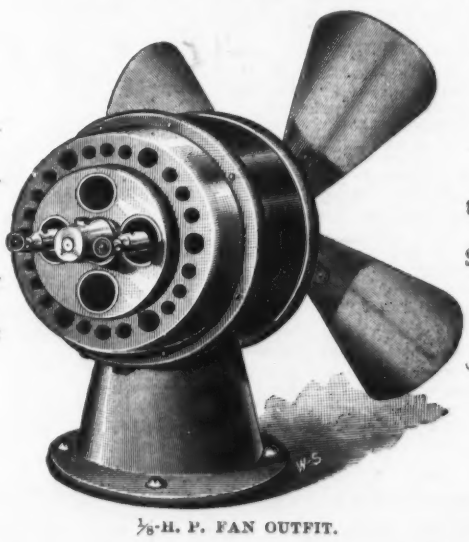

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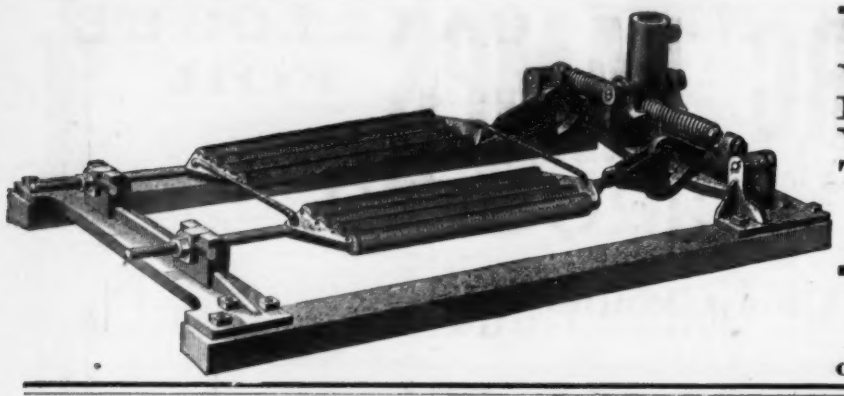

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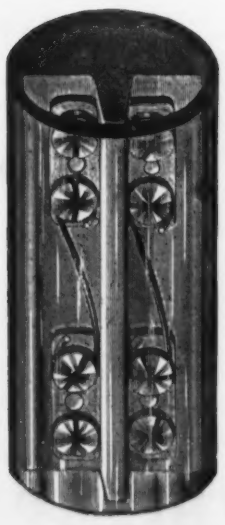

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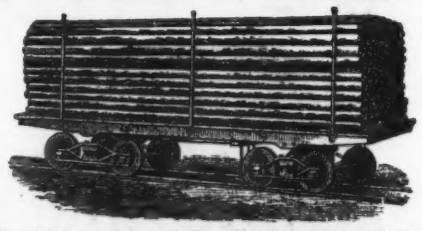

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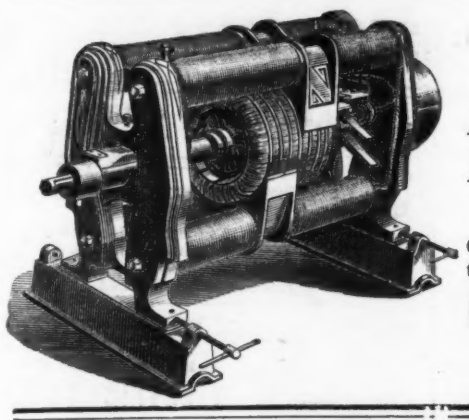

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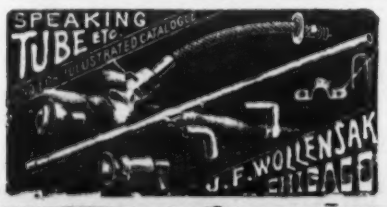

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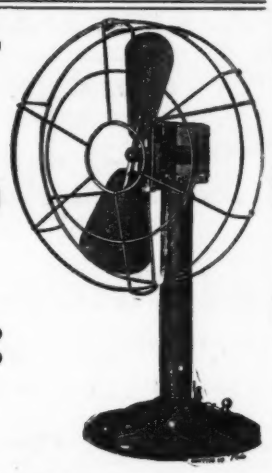

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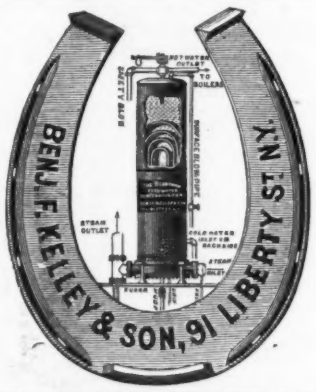

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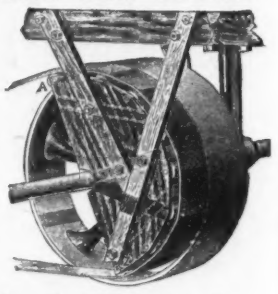

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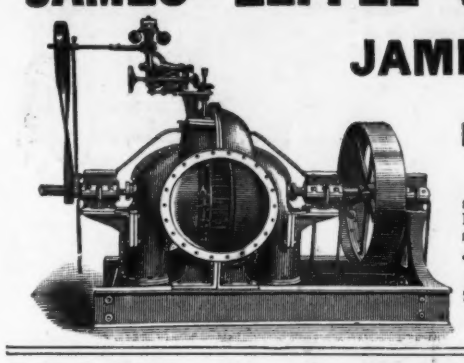

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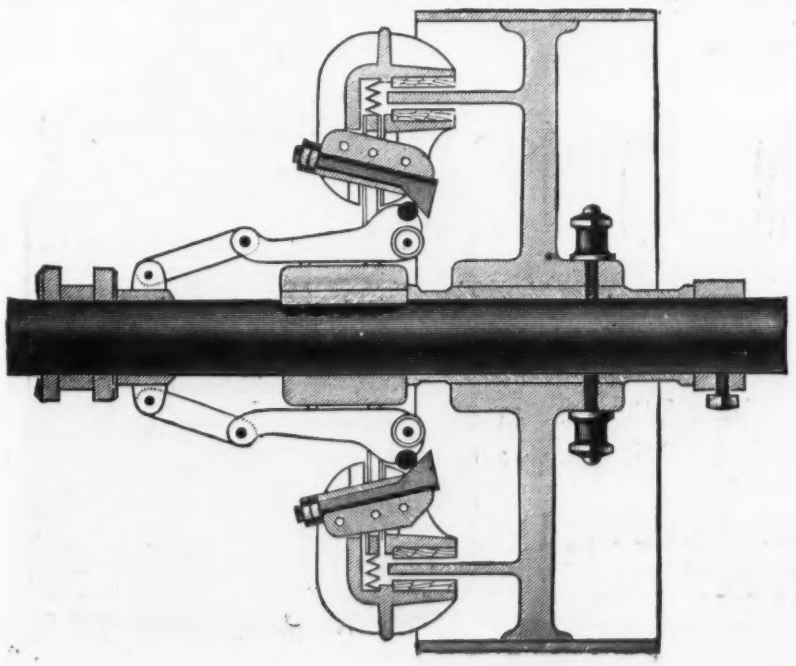

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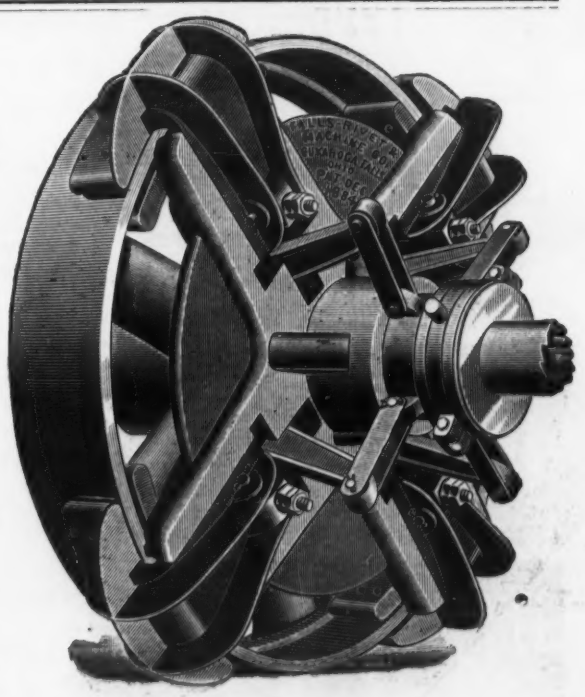

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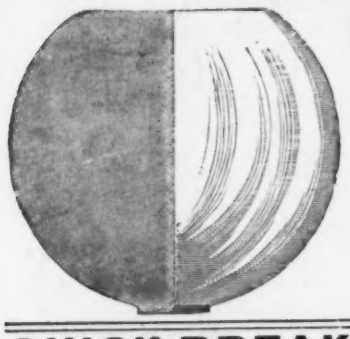

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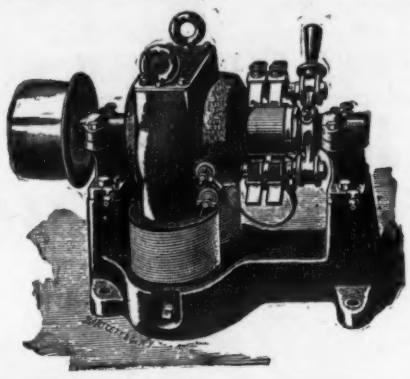

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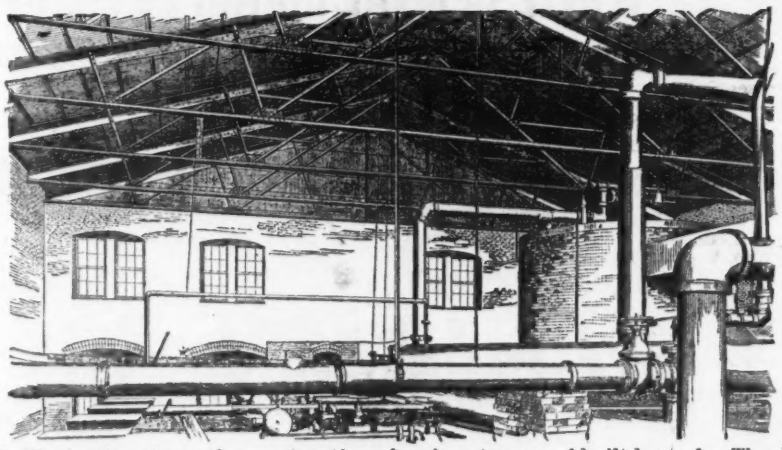

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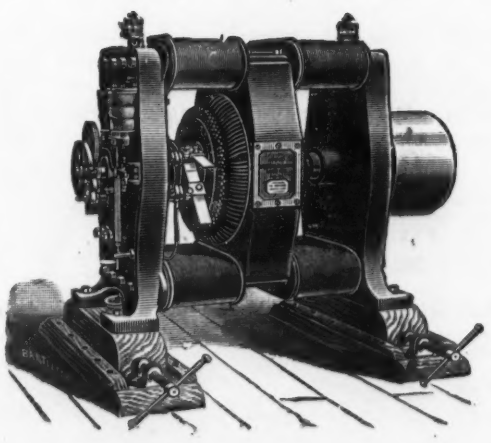

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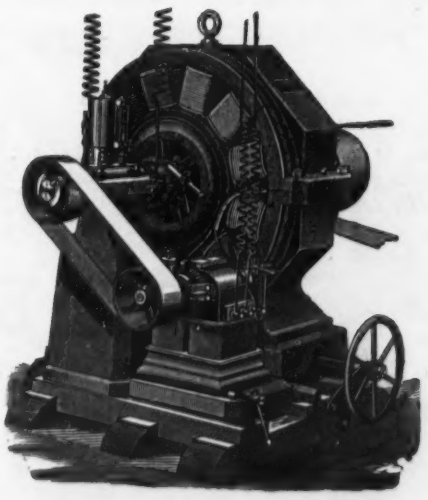

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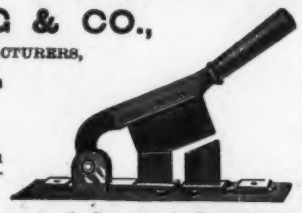

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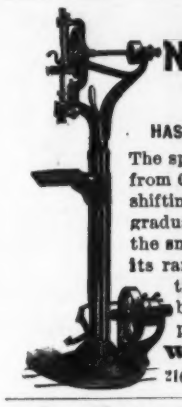

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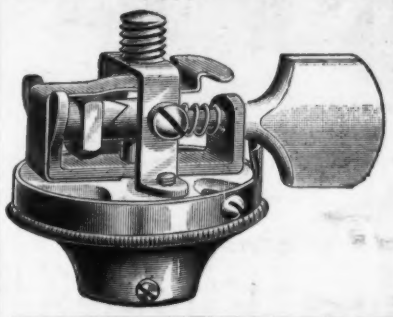

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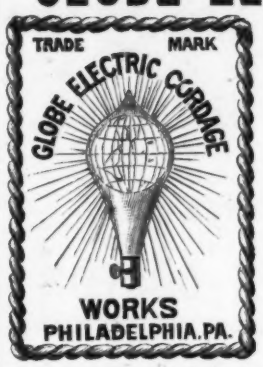

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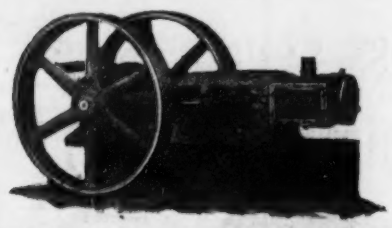

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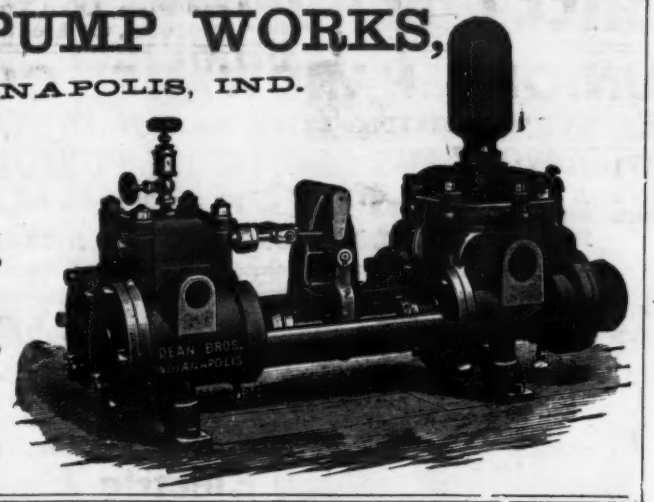

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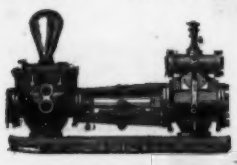

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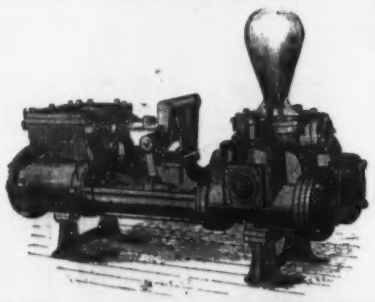

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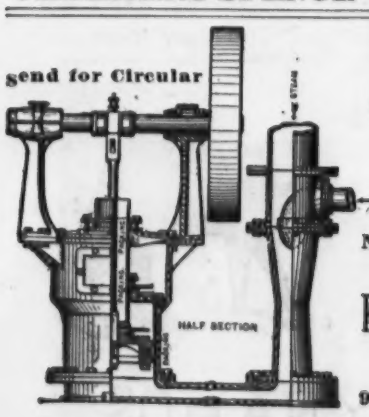

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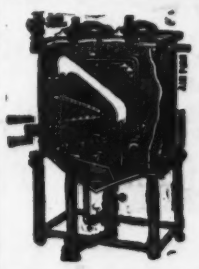

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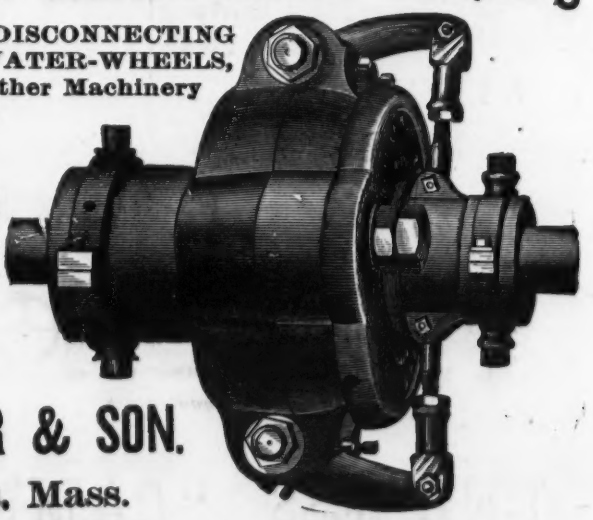

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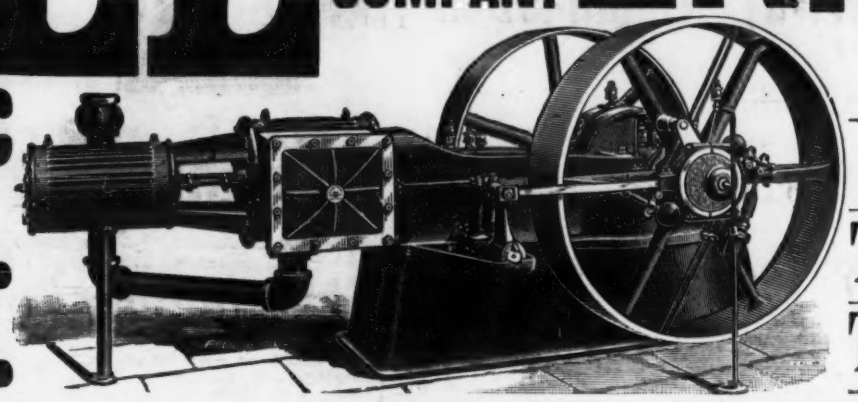

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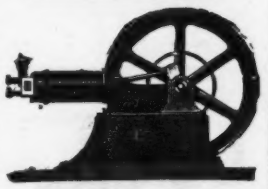

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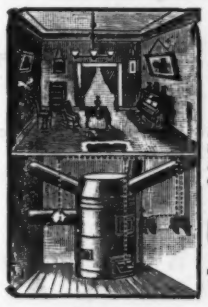

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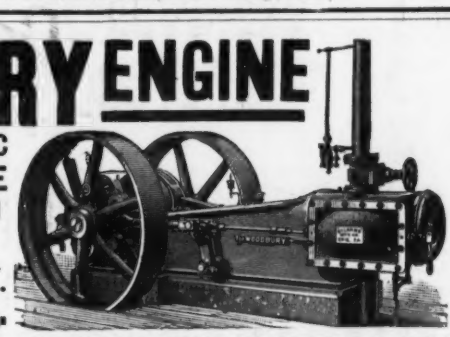

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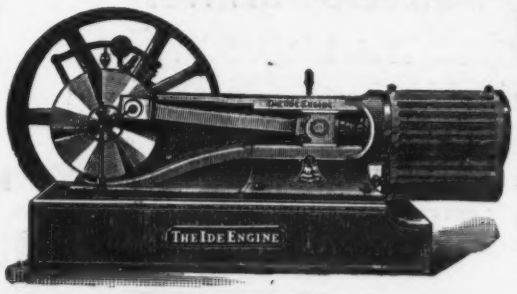

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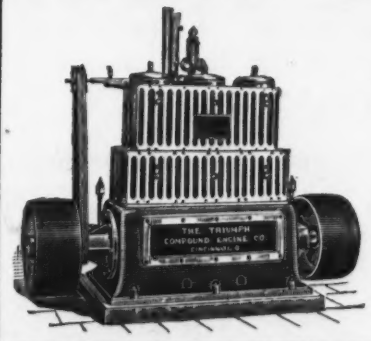

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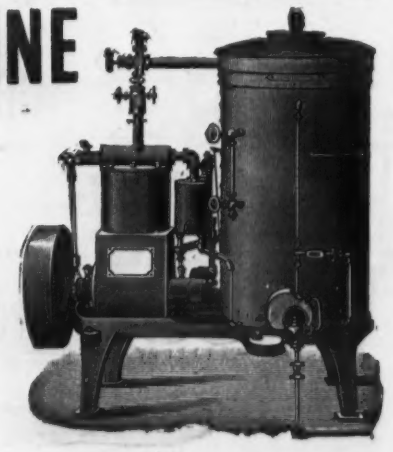

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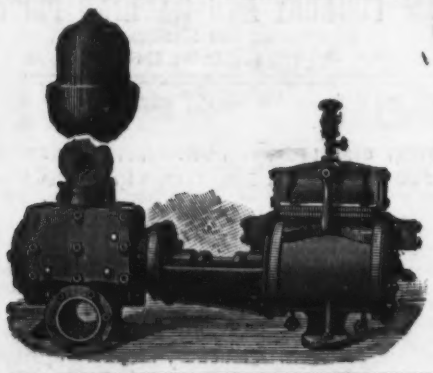

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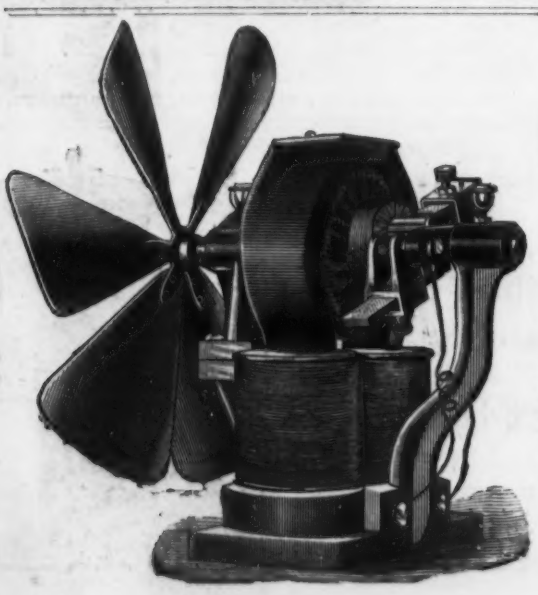

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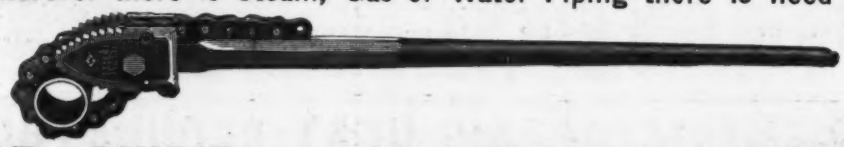

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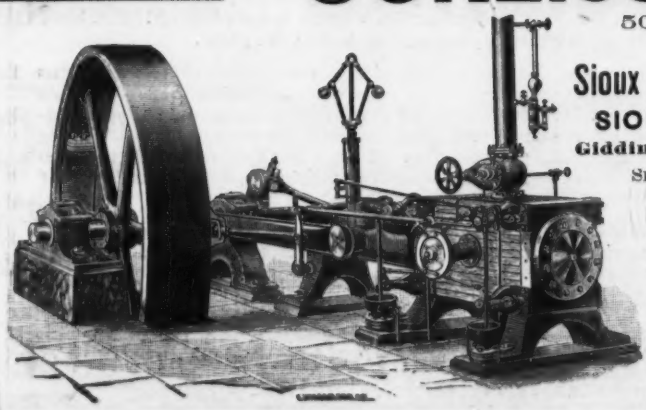

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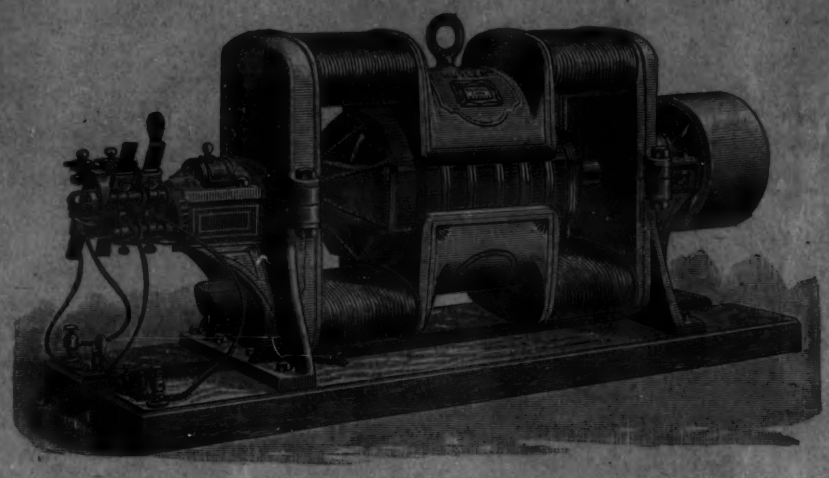

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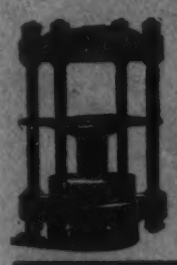

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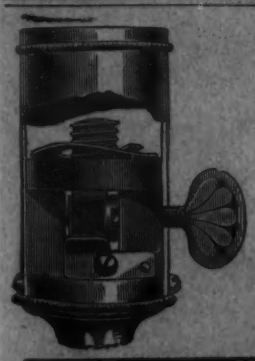

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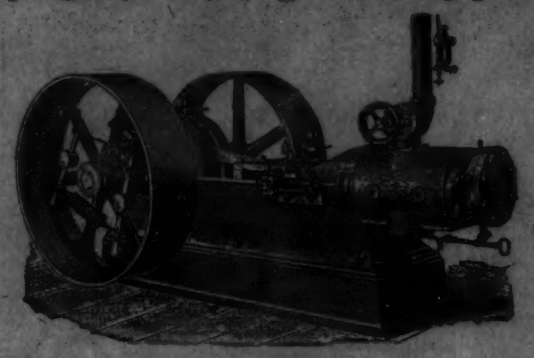

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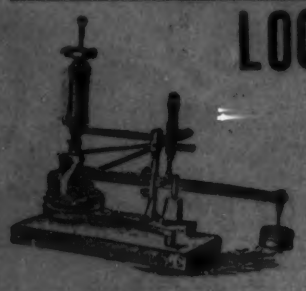

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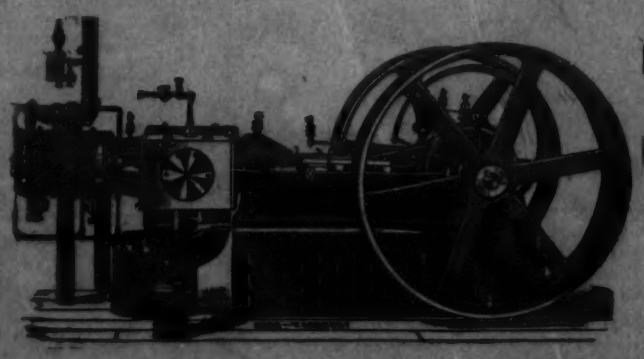

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